MEDICINE

An International History

PAUL HASTINGS

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Infectious disease has been a deadlier enemy to mankind than war. Armies themselves have been conquered by it. Malaria decimated the hosts of Sennacherib before Jerusalem and completed the downfall of the Roman Empire. Of some 300,000 Crusaders who left Western Europe in 1096, only 20,000 reached the Holy City. Bubonic plague destroyed a third of the people of medieval Europe, and smallpox, rather than gunpowder, ensured the conquest of the New World. Typhus killed 300,000 French soldiers in the Peninsular War and completed the ruin of Bonaparte's Moscow campaign.

Medical practice is as old as man, but its progress has been erratic. It began as magic and folklore, and, by the time of ancient Greece, it was a carefully studied science. Rome initiated the first true public-health system, but, with the collapse of that empire, medicine, except in the Arab lands, reverted to magic and superstition. Only the traumatic effect of the Black Death and the inquiring spirit of the Renaissance produced a revival of medical learning. Slowly, over the next four hundred years, medicine again became a science. The invisible demons of disease were exposed under the microscope, and man learned to counter them with vaccines, drugs, and surgery. The devasting cholera outbreaks of the nineteenth century brought a revolution in public health parallel to that in medicine and surgery. X rays revealed the skeleton. Later, vitamins, sulphonamides,

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Today, a man of seventy can claim that more medical progress has been made in his lifetime than in all previous history. But the struggle is eternal. In the developed countries, modern society has produced fresh maladies and new problems. In the underdeveloped countries the population explosion complicates urgently needed medical progress.

Paul Hastings's account is rich in detail, and he presents an important subject in a vivid and absorbing style.

THE AUTHOR: Paul Hastings was educated at Birmingham University in England. He is head of the History Department at Middleton St. George College of Education.

His previous books include *Between the Wars*, *The Cold War*, and *Railroads: An International History*.

Cover Photograph: A Flemish physician from a manuscript of the fifteenth century, by kind permission of the Radio Times Hulton Picture Library

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PAUL HASTINGS

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BOOKS THAT MATTER

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TITLE-PAGE is from a Byzantine manuscript and shows an apothecary's shop

Contents

Introduction

THE HISTORY OF MANKIND is in many respects the history of its diseases. Infectious disease has been a more deadly enemy to man than war – hence the ghastliness of the modern concept of bacteriological warfare. When one studies the constant epidemics of the past and its deficiency diseases it is amazing that mankind has survived at all. Armies and empires have been brought low by disease. Malaria decimated the hosts of Sennacherib before Jerusalem and helped to complete the downfall of the Roman Empire. Of some 300,000 Crusaders who left western Europe in 1096 on the First Crusade only 20,000 finally reached the Holy City. Bubonic plague destroyed a third of the people of medieval Europe, creating economic and social chaos. Smallpox played a large part in the conquest of the New World by Spanish *conquistadores* and English Puritans. Typhus killed 300,000 French soldiers in the Peninsular War and completed the ruin of Bonaparte's Moscow Campaign.

Medical practice is as old as man but its progress has been neither regular nor inevitable. It began as magic and folklore, to which modern medicine still owes a debt. By the time of ancient Greece it had become a carefully studied science. Rome initiated the first true system of public health but with the collapse of her empire most ancient medical knowledge was lost and medicine, except in the Arab lands, reverted to magic and superstition. Only the traumatic effect of the Black Death and the inquiring spirit of the Renaissance produced a revival of medical learning. Slowly during the next 400 years man discovered the nature of his body and mind and medicine again became a science. The invisible demons of disease were revealed by the microscope and he learned to counter and destroy them with vaccines, drugs, and surgery. The devastating cholera outbreaks of the nineteenth century brought a revolution in public health parallel to that in medicine and surgery which paved the way for the amazing achievements of the twentieth century.

Today a man of seventy can justly claim that more medical progress has been made in his lifetime than in all previous history. X-rays have made the skeleton visible. The ancient epidemic diseases have been beaten by dedicated scientific research and a deep concern for humanity. Vitamins, sulphonamides, and antibiotics have been added to medicine's armoury. Surgery has accomplished seemingly impossible tasks aided by dramatic technical progress in the 'machine age of medicine'. Average life expectancy has increased and medical facilities have become available on a hitherto unparalleled scale.

Without this medical advance material progress in other spheres would have been impossible. Yet the struggle is eternal, for, in the developed countries, which have benefited most from these advances, modern society has produced its own fresh maladies which are urgently in need of cure together with the problem of caring for the increasing numbers of the aged. In the underdeveloped lands a population explosion threatens to bring future political, social, and medical catastrophe unless medical and economic aid are freely given. Yet, if they are, world population could outstrip the resources of the earth unless its expansion is halted.

Mummified face of the Egyptian Pharaoh Ramses V showing disfigurement by smallpox (*see page 10*)

1 The first medical men

DISEASE AND INJURY are older than mankind. Before man's appearance animals suffered their pain helplessly with relief only from nature. The earliest men suffered similarly. The skull of Rhodesian man, discovered by archaeologists, suggests that he died agonizingly alone, crazed by an acute mastoid infection which added to his existing pain from rotting teeth and dental abscesses. Neanderthal man, the first true man, was undoubtedly afflicted with chronic arthritis arising from his habitation of rock shelters. While shattered limbs were frequently the result of accident in a hunting and food-gathering economy, the fractured skulls of South African and Java ape men and the Peking men found at Choukoutien show that prehistoric man's medical problems 450,000 years ago were intensified by his own propensity for violence.

Unlike the animal world, the descendants of early man tried to help the sick rather than leaving them to die alone. They did not recognize that disease or death arose from natural causes, so these were ascribed to evil spirits sent as punishment for disobedience by the gods or activated by human enemies. Since disease was regarded as a magico-religious phenomenon it was treated by medicine-men, who have been called 'the oldest professional class in the evolution of society', and whose prime role was to drive out evil spirits, using nauseating concoctions. On other occasions they might resort to the remarkable surgical operation known as 'trephining', practised up to modern times in remote parts of Europe, America, and the Pacific. This consisted of cutting a small hole in the cranium. Hundreds of prehistoric skulls, upon which this operation had been performed, have been discovered by archaeologists in different parts of the world. When the first skulls were found in France in 1685 the holes were thought to be battle wounds. Not until 1867 were they recognized as deliberate cuts made by a flint knife. While some trephinings ended in death, the majority show unmistakable signs of healing, a clear

1 Statuette of the god Imhotep the Vizier-Physician who became an Egyptian god of medicine

indication that the patient had survived for at least several years. In some cases multiple trephining had been performed on different occasions upon the same skull. In 1962 Francisco Grana, a Peruvian brain surgeon, proved the effectiveness of prehistoric instruments by successfully using them in a trephining operation upon a patient paralysed by a blood clot beneath the cranium. Why so widely practised an operation was performed we can only guess. Initially perhaps it was intended to release evil spirits causing migraine, epilepsy, paralysis, or insanity. Subsequently it was used to treat head injuries arising from battle or accident.

Eighty per cent of Neanderthal men were dead by the age of thirty. Their Cromagnon successors fared little better. Nevertheless it seems likely that until the Neolithic revolution began to crowd people into larger communities ailments which became the scourges of historic times were rare or unknown. Once Neolithic man began to settle, domesticate animals, and till the soil, he became vulnerable to tetanus and many other diseases which rose to epidemic proportions. Tuberculosis is identifiable in human bones from Neolithic times.

2 An Egyptian gravestone of the eighteenth dynasty. The priest is offering sacrifices to Istar, god of health. His deformed right leg undoubtedly results from poliomyelitis in early childhood

By the time the first great civilizations had appeared in Mesopotamia, Egypt, India, and China it had been joined by malaria, smallpox, typhus, typhoid, and leprosy. Until the twentieth century, although it was known that the advanced communities which, from 4000 BC, grew up in the valleys of the Nile, Tigris, and Euphrates were capable of writing, high standards of art, craftsmanship, and social organization, it was thought that the Greeks were the founders of true medicine. It is now clear that although still closely linked with magic and superstition a body of sound medical knowledge had developed over 2,000 years before the first Greek physicians appeared. Evidence of Egyptian medical practice is based upon tomb inscriptions and objects, the scientific examination of mummies, which reveals the diseases from which Egyptians suffered, and a handful of medical papyri which date back to perhaps 2160 BC. Egyptian physicians were priests trained in temple medical schools in surgery as well as medicine. The Greek historian, Herodotus, recorded in 450 BC that

> Each physician treats a single disorder and no more. Thus the country swarms with medical practitioners, some undertaking to cure diseases of the eye, others of the head, others again of the teeth, others those of the intestines, and some those which are not local. . .

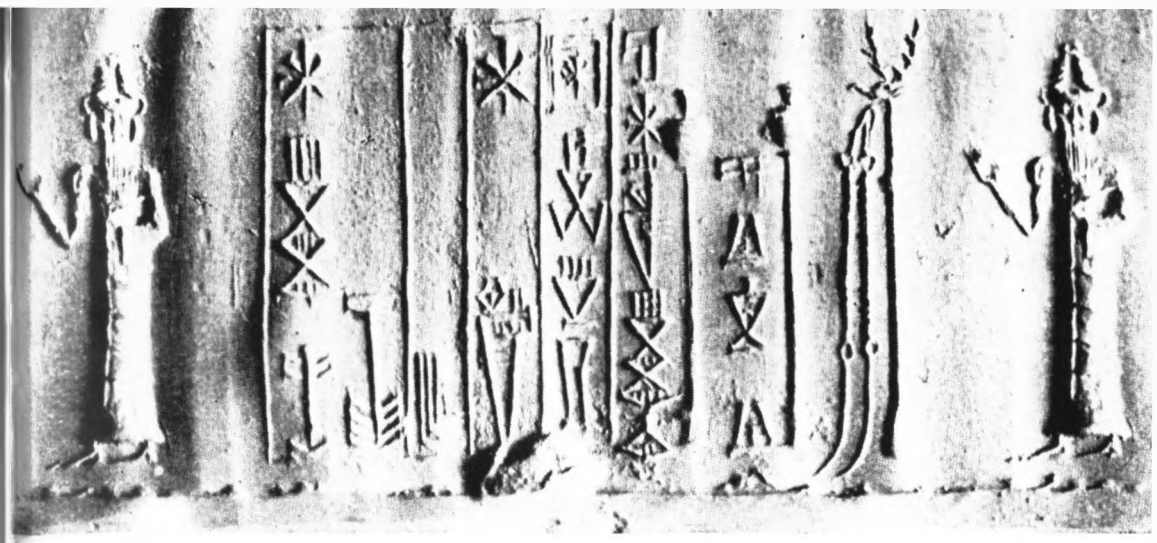
Where there was no obvious cause of an illness it was attributed to spirits of the wicked goddess, Sachmet, who brought sickness and death. The physician's first task was to drive out these demons with spells. If this failed repellent concoctions were used to persuade them to quit. Excrement used included that of the lion, panther, gazelle, and ostrich. Crushed or live insects were also swallowed together with raven's backbone and fat from black snakes. Although Egyptian medicine undoubtedly developed out of magic, and drugs used were originally selected for their magical rather than healing qualities, a papyrus discovered by the German professor Georg Ebers, in 1875, revealed that the ancient Egyptians also used at least a third of the medical plants utilized in modern pharmacy.

As masters of embalmment and mummification the Egyptians had also a better knowledge of anatomy than other ancient peoples. Although these arts were far removed from deliberate anatomical dissection, special hieroglyphic symbols existed for such organs as the stomach, liver, windpipe, bladder, and womb. Egyptian doctors not only saw the heart when it was removed for mummification. They also felt the pulse and perhaps counted it. Certainly they recognized that pumping movements affected all parts of the body, and that 'channels and strands' led from the heart to all body parts. Just as the Nile and its irrigation channels fed all life in Egypt so Egyptian physicians viewed the human body as a system of canals. In illness these were choked with blood or other substances which created pain and sickness. It was, therefore, as essential to remove such blockages as those in the national system of irrigation.

Intestinal stoppages were met with enemas of ox-gall and fats administered through a cattle horn. Stoppages and inflammation of the blood were countered by bleeding or the application of leeches. A leech consumes four times its weight in blood and with it disease-producing toxins. When full it drops from its host of its own accord. Not only does it reduce blood pressure, but while it sucks it emits hirudin, preventing coagulation. Purging and bleeding remained principal resources of doctors into the nineteenth century, but it was

perhaps in the art of surgery that the ancient Egyptians made the greatest advance. A papyrus, uncovered by the American Egyptologist Edwin Smith, in 1862, proved to be the oldest known surgical textbook in the world. Written about 1500 BC its forty-eight cases, ranging from injuries of the head to the lower spine, described surgical practice of at least a thousand years before. Gone were the magic and the exorcisms. Fractures were not only set using linen bandages dipped in pitch, instead of modern plaster casts, but were splinted with stiff pieces of raw hide. Wounds were closed with linen strips soaked in sticky resin or had slices of fresh meat applied to them which helped the blood to clot. The latter practice doubtless originated out of sympathetic magic, but infection and inflammation were combated with a solution of leaves of willow or by cauterization which remained in use for centuries to come. In addition to its sections upon internal disease and surgery the Ebers Papyrus contains a chapter upon eye diseases, which are still so common in modern Egypt. Egyptian eye doctors could distinguish between conjunctivitis, cataract, and the dreaded trachoma which frequently brings blindness. Among the treatments for trachoma were copper, alum, and aluminous clay – very similar to those of the twentieth century. Egyptian eye ointments, to give protection against the glaring sun and desert wind, also contained medicaments not unlike those of modern prescriptions.

The benefits of Egyptian medicine were reserved for the rich. For the fellaheen, living in squalid overcrowding and drinking the filthy waters of the Nile, disease lurked everywhere. Polluted water meant dysentery, enteritis, typhoid, and cholera. Mosquitoes from the canals brought malaria to the lowland villages. From the examination of mummies doctors have identified cases of infantile paralysis, tuberculosis, and rickets. Chronic rheumatism arose from scanty clothing and the great fluctuations in temperature between day and night. In the canals was the debilitating intestinal bilharzia worm which is still the terror of Nile Valley dwellers. If the mummy of Ramses V bears the lesions of smallpox what proportion of his subjects fell victim to this same killer disease? The presence of toilets and washrooms in the homes of the poor as well as the rich in the short-lived, town-planned city of Akhet-Aton, built in about 1370 BC is not evidence that Egyptian rulers were unduly concerned



3 An imprint of the seal of a Sumerian physician *c.* 3000 BC showing a representation of Nergal, the god of disease and plague

with public health. It may, however, represent the realization that infectious diseases among the masses had the disconcerting habit of spreading to their betters. The distribution of radishes, onions, and garlic in the barracks of the armies of pyramid labourers also perhaps had a medical purpose based upon experience. In 1948 Swiss scientists discovered that these vegetables contain antibiotic properties effective against dysentery, typhoid, and cholera. No other explanation has yet been advanced to explain how such vast numbers of workmen remained undecimated by epidemics.

Egyptian physicians were too conservative to develop their medical knowledge into a scientific system. Priestly traditions ensured that while a physician adhered to the rules of the Sacred Books he was free from blame if a patient died. If a patient died from treatment of the physician's own making he was executed. In the absence of experiment medical progress was impossible. None the less, Egyptian medicine was much more than mere 'sewerage pharmacology'. In their day Egyptian doctors were famed throughout antiquity and in demand even in Mesopotamia, whose medical system was equally surprising to the modern world. The Sumerian civilization, which first evolved in the fertile Tigris-Euphrates valleys about 4000 BC, equalled if not surpassed that of Egypt. That its medicine began as

4 Fragments of Assyrian medical texts from Ashurbanipal's library in Nineveh

early as Egyptian medicine is proved by the existence of the seal of a Sumerian physician who practised about 3000 BC. The Sumerian medical tradition was inherited by the Babylonians and Assyrians who conquered Sumeria a thousand years later. Sumerian medicine was again largely magico-religious. Most of its surviving medical texts were found upon clay cuneiform tablets in King Ashurbanipal's library, established at Nineveh in the seventh century BC.

Mesopotamia, with its debilitating climate, suffered more from disease than Egypt. The sudden death of Alexander the Great at Babylon in 323 BC is but one example of the terrible power of malaria in the Tigris-Euphrates valleys. It was no accident that Nergal, Mesopotamian god of plagues, was represented as an insect. Medical problems were accentuated by poorer personal hygiene which involved washing only on festive occasions. Many remedies of the physician-priests consisted of incantations to expel demons of such wrathful gods as the repulsive Pazuzu, the 'Gripper', with his clawed

hands and feet. They understood, however, the pharmaceutical value of some 250 plants and 120 mineral substances including many, such as cassia, myrtle, thyme, willow, belladonna, and potassium nitrate, which were known to the Egyptians. Slaves and the subjugated served as human guinea-pigs. Like the Egyptians, Sumerian physicians administered internal medicines with beer, although scientists only discovered centuries later that yeast contains Vitamin B.

In contrast, as a guide to the outcome of illness, Babylonian doctors examined a sacrificed sheep's liver for omens and consulted the stars, which it was believed influenced human action and disease, a practice which found adherents throughout the Middle Ages and into modern times. Seven was a mystic number. Doctors did not treat the sick upon this dangerous day or its multiples. No surgical texts have yet been found although archaeology has revealed a small number of surgical implements. None the less, by 2000 BC the legal code of the Babylonian ruler, Hammurabi, points to the existence of surgery and a highly organized medical profession whose conduct and fees were prescribed by law. Hammurabi's system of medical ethics involved, however, considerable perils for the unsuccessful surgeon:

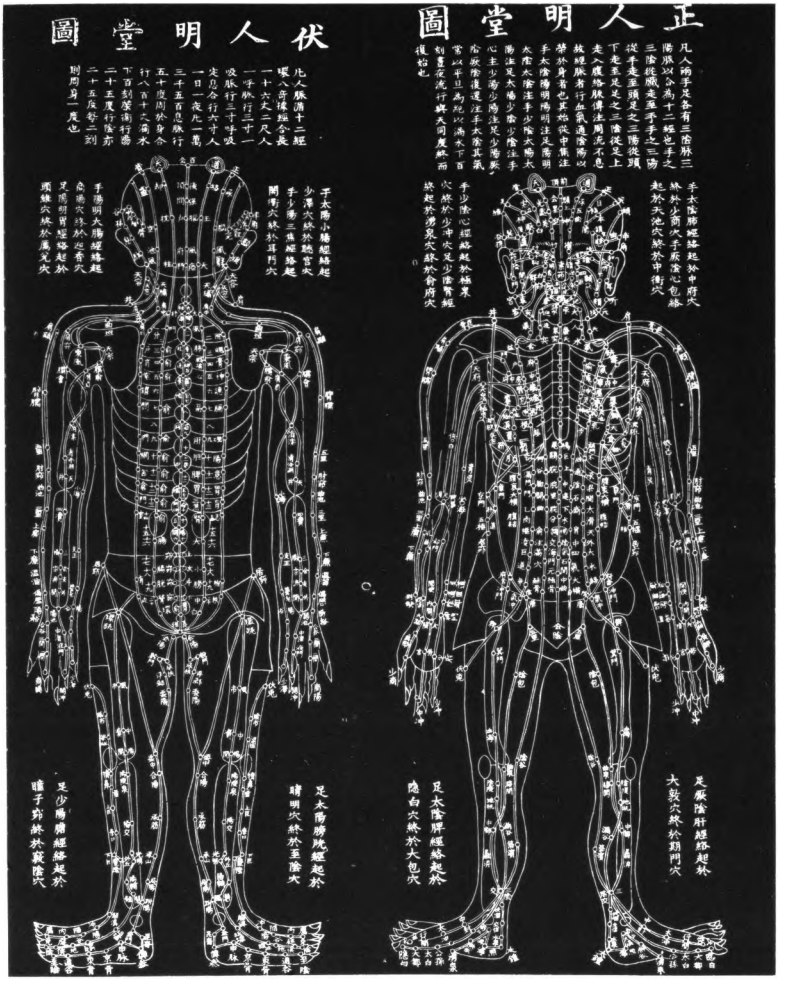
> If a physician has treated a nobleman for a severe wound with a bronze lancet and has cured him, or opened a nobleman's eye abscess and has cured it, he shall take ten shekels of silver. If he be a free man he shall receive five shekels. If the patient is a slave his master shall pay two shekels of silver. . . . If the physician shall kill the patient or destroy the sight of the eye his hands shall be cut off. . . .

The latter penalty, which must have deterred many potential doctors, applied only to a noble patient. In the case of a slave the doctor merely 'rendered slave for slave'. It is no coincidence that many of the drugs used in Mesopotamia, including cannabis or Indian hemp, came from India. The Mesopotamians, like the Egyptians, had undoubtedly established trading contacts with the rich Indus Valley civilization as early as the third millennium BC and a sharing of pharmacological knowledge resulted. The earliest of Sanskrit writings, the *Rig-Veda*, written about 1500 BC consists largely of incantations for priest-doctors. Mention is made, however, of sages who accompanied the wandering Aryan tribes with bags of

healing herbs. These men not only treated wounds but removed eyes and limbs and made artificial organs to replace them.

Later sacred books contain much more medical information. The symptoms of the great Indian killer diseases malaria, dysentery, typhoid, cholera, plague, leprosy, and smallpox are described. There is mention too of the world's first nurses and hospitals and the extensive use of drugs. Drugs for anaesthesia undoubtedly helped in the main Hindu contribution to the art of healing – surgery. Although Hindu knowledge of anatomy was limited, Susruta of Benares, writing in the fifth century AD, lists some 120 surgical instruments used in many different operations from couching for cataract to the replacement of a severed nose by a forerunner of plastic surgery. In the field of hygiene the excavation of the ancient Indian cities of Harappa and Mohenjo-Daro suggests that early India was superior to Egypt and Mesopotamia. Brick-walled sewers drained both the main and the poorer side streets of Mohenjo-Daro, which also possessed underground water-pipes. Its massive swimming-pool was equipped with steam-baths, drains, and fountains. In the Nile Valley and the Land of the Two Rivers such facilities were limited to the dwellings of the rich. Hindu medicine declined with the Moslem conquest of India but from the middle of the first millennium BC a vast amount of its medical knowledge and drugs had spread to the Mediterranean lands by many routes.

It is perhaps surprising that the Chinese made no progress in the art of surgery which flourished so amazingly in near-by India. However, ancient China was also a highly developed centre of early medical learning. The Emperor Shen Nung, who lived in about 3000 BC was the 'Father' of Chinese medicine. His *Pen Tsao*, or Great Herbal, contained over a thousand drugs, some of which are used today. Although initially controlled by magic and sorcery like the medical treatment of other early civilizations, Chinese medicine gradually freed itself to make its own discoveries. By the second millennium BC Shang priests were scratching upon oracular bones, used to petition the gods, the various symptoms of diseases. A thousand years later T'ai I Ling, the Chief Court Physician, was of sufficient importance to be paid an annual salary of 600–1,000 bearer loads of rice. Acupuncture, the practice of healing by the insertion of needles into certain areas of the skin, was a Chinese discovery originating from attempts to drive demons from the sick. An artificial irritant designed



5 Chinese diagrams showing the points for acupuncture. Needles were of metal or stone and were used hot and cold

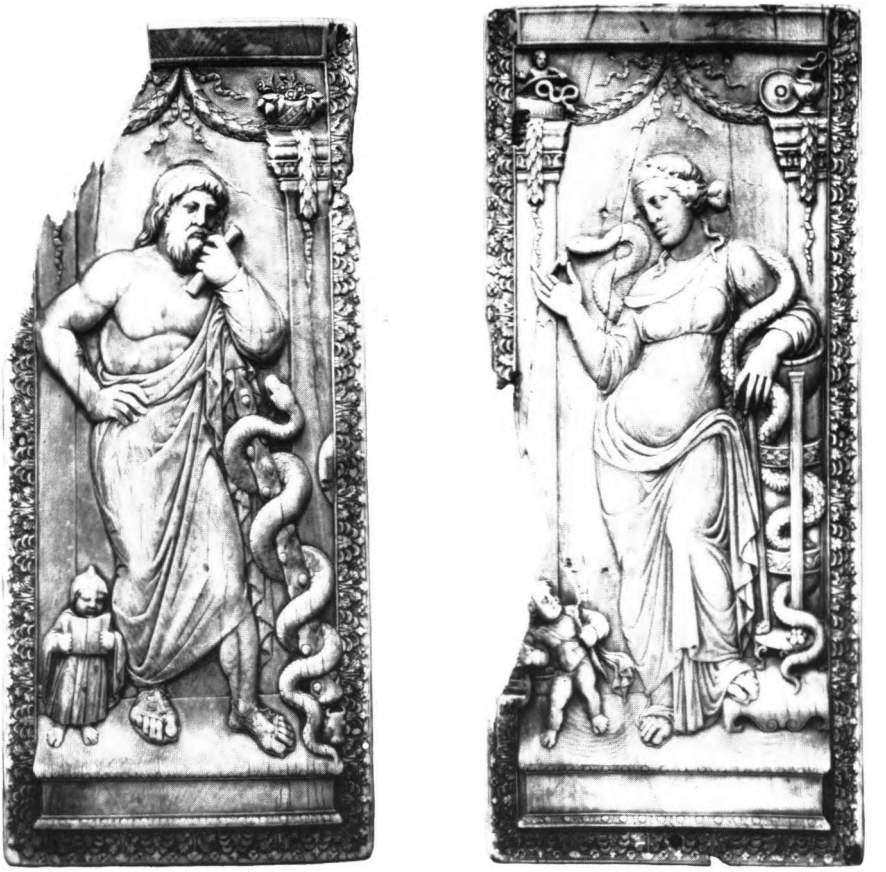
to remove an existing irritation, it is used to counter sciatica and fibrositis today. Massage was also of Chinese origin. Chinese doctors first used mercury to treat ulcers 2,000 years before Europeans adopted it for the treatment of syphilis. They also concluded that the blood circulates in the body under the control of the heart centuries before William Harvey, while Chang Chung-Ching, who lived in about AD 195, has won the title of the 'Chinese Hippocrates' because of his insistence upon the study of the symptoms of disease.

2 Greece and Rome

MODERN CIVILIZATION owes an immese debt to the ancient Greeks, a mixed multitude of invaders who from about 2000 BC were moving into the Greek peninsula and islands and the western regions of Asia Minor. Here they established the most remarkable civilization of all time. The medical system they developed first took shape in Asia Minor and spread throughout the Greek world. Knowledge acquired from Babylon, Egypt, India, and possibly the conquered peoples of Minoan Crete played an important part in its evolution. Its beginnings are shrouded in legend in which healing and religion are hopelessly intermixed. Apollo, the sun god, was also god of health and medicine. His birth-place, the isle of Delos, was both a medical centre and a shrine. Apollo taught the art of medicine to the centaur, Chiron, who in turn instructed Jason, Achilles, and Asklepios. The last-named, who may have lived about 1250 BC, taught his sons Podalarius and Machaon, who according to the poet Homer tended the Greek armies at the siege of Troy.

By the mid eighth century Asklepios had become the Greek god of healing, with the symbol of a sacred snake whose significance has never been satisfactorily explained. His daughter, Hygeia, was goddess of health. Temples called 'Asklepieia' sprang up where priest-physicians supervised the healing ceremony of incubation, or temple sleep. The patient purified himself by bathing and made offerings to Asklepios. Then after reading the votive tablets describing the cures of former patients, thus preparing mentally for his own cure, he lay down to a drug-induced sleep in the temple colonnade. During the night harmless sacred snakes licked his wounds and Asklepios addressed him, and applied salves. If the votive tablets are to be believed upon waking the patient was invariably cured:

> Agestratos suffered from insomnia on account of headaches. As soon as he came to the colonnade he fell asleep and had a dream. He thought . . . the god cured him of his headache and . . . taught him wrestling.

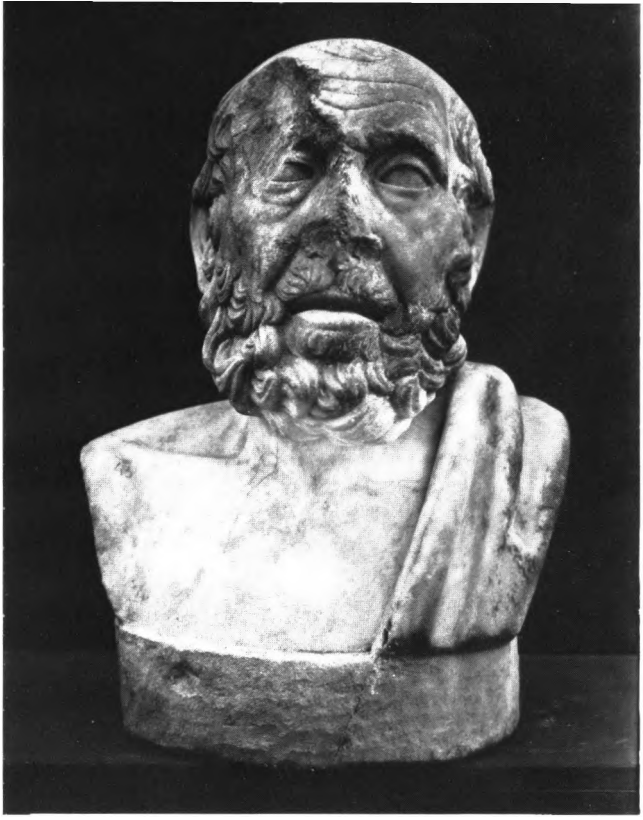


6 Asklepios, the Greek god of healing, and his daughter Hygeia, goddess of health. Both are shown with the sacred snake

. . . When day came he departed cured and . . . he competed at the Nemean Games and was victor in wrestling.

The cures of the Asklepieia could be attributed to psychotherapy. The absence of failures creates some suspicion. Incubation continued into Christian times but the Asklepieia gradually became more like spa resorts.

The presence of military surgeons with the army that invested Troy shows that Greek medicine, even at this early date, was not solely theocratic. As the Greeks colonized the Aegean Islands and Asia Minor they absorbed the ideas, drugs, and methods of the earlier



7 A Roman copy of a Greek bust of Hippocrates found at Ostia on a pedestal bearing the Hippocratic oath

civilizations of the Near and Far East. Their insatiable spirit of inquiry drove them to question accepted knowledge and seek further information for themselves. Pythagoras, the philosopher-mathematician, encouraged his pupils to investigate the causes and reasons of nature, thus beginning a tradition of medical inquiry. A pupil of Pythagoras, Alcmaeon of Croton, who lived in about 500 BC, dissected animals to study sight and hearing, while Empedocles, also from Croton, applied to medicine the idea that the world consisted of four elements: earth, air, fire, and water. In the body the elements were yellow bile (*chole*) which was dry; phlegm (*pituita*) which was cold; blood (*sanguis*) which was hot; and black bile (*melanchole*) which was moist. Imbalance affected health and character. Thus a surfeit of black bile produced melancholy. This theory dominated medical

thought for centuries before giving way to scientific theories of disease. Empedocles also believed that blood gave life and the heart distributed it round the body. By the time Greek civilization reached its peak in the fifth century BC the medical schools at Cnidus in Asia Minor and the Aegean island of Cos had started to observe what happened in illness, rather than accept the theories and medicines of the past. Upon the island of Cos, Hippocrates, the founder of scientific medicine, was born in about 460 BC. Before he died at the age of ninety-nine he had taken medicine out of the realm of priests and philosophers and produced an organized method of securing knowledge by means of observation.

Little is known of Hippocrates himself. Born into a family of Asklepiads, or priest-physicians, he received his early tuition from his father before travelling widely to study under the most distinguished teachers of his day. His studies completed, he practised in many parts of the Greek world and won such fame for the cure of apparently hopeless cases that the Persian emperor, Ataxerxes, tried to persuade him to become his Court Physician. Athenians especially benefited from his skill. In 430 BC at the height of the Peloponnesian War, when the city was besieged by the Spartans, overcrowded and insanitary conditions created by hordes of refugees produced an outbreak of louse-borne typhus which follows in the footsteps of war and famine. The Athenian historian Thucydides, who caught the disease himself, described it in graphic detail. It was Hippocrates who finally halted its spread and a grateful Athens erected a memorial in his honour. Seventy-six treatises survive that have been attributed to Hippocrates. Most were written by his pupils and later disciples. Some, however, such as *The Prognostics*, *On Airs, Waters, and Places*, *On Fractures*, and *On Surgery* were clearly written by Hippocrates himself. Equally authentic is his oath of service for doctors whose code of behaviour medical schools still teach:

> I swear by Apollo, the physician . . . that to the limits of my ability I will keep this Oath . . . that I will follow whatever regimen I believe to be for the good of my patients and will refrain from whatever is harmful and injurious. I will dispense no dangerous medicine. . . . I will pass my life in purity and holiness and likewise will I practise my Art. . . .

Hippocrates taught that illness was the result of natural causes

and not punishment for sin or the work of evil spirits. To find its cause doctors needed to examine a patient's environment – his home, its climate, and his place of work. Medical knowledge could only be acquired by accurate clinical observation of the sick. His own case histories were models of clarity and conciseness as a description of what may have been a case of blackwater fever shows:

> Philliseus lived by the wall. He took to his bed with acute fever on the first day and sweating; night uncomfortable. Third day – until midday he appeared to have lost the fever but towards evening . . . sweating, thirst, dry tongue, black urine. Sleepless; completely out of his mind. Fifth day – distressing night, irrational talk, cold sweat. About midday on the sixth day he died. The breathing throughout . . . was rare and large.

Although they had little knowledge of anatomy or physiology, the ability of Hippocratic surgeons was beyond doubt. Without anaesthetics or sterilized instruments they performed successful operations for fractures, piles, bladder and kidney stones, tumours, hernia, and gangrenous limbs. Scrupulous cleanliness was observed. Before operating nails were pared and hands cleansed. Natural or artificial light was adjusted to provide maximum illumination. Infection was avoided by blood-letting. The patient was held still by assistants in the required position. Nevertheless he experienced excruciating pain.

Although Hippocrates stressed the need for observation he accepted the theory of humours. He was, however, the first doctor to break from past magical theories of disease and lay the basis, through observation, for all further medical work. His contemporary, Aristotle, the philosopher and scientific genius who became tutor to Alexander the Great, was responsible for linking medicine with biology, botany, and anatomy. As human dissection was illegal, his findings were based upon the dissection of animals. However at Alexandria in Egypt, one of the many cities of this name created by Aristotle's former pupil, human dissection was practised. With its library of 700,000 books, used by students from throughout the ancient world, Alexandria became a centre of learning and the home of a famous medical school. It declined, however, as Alexander's empire gave way to that of Rome, and with this decline medicine again reverted to supernatural theories of disease.

Medicine was considered beneath the dignity of the Roman citizen.

8 A votive tablet from the Temple of Asklepios in Athens, depicting the cure of a case of phlebitis

The head of an early Roman household distrusted and despised the wandering Greek physicians who came to Italy from about 200 BC, often as slaves. He ministered to his own family, using treatments similar to those of primitive and early civilized man. The widespread use of concocted drugs returned. One of the best known was theriac, an antidote for poisons which included viper's flesh among its sixty-two ingredients. 'Never', stated one writer, 'has a medicine containing so much cured so little.' Nevertheless it remained in use in the early nineteenth century. Only after Julius Caesar gave physicians rights of full citzenship in 46 BC did they begin to achieve any status in the Roman world. Even then the great demands of private practice, public service, the army, and the gladiatorial schools left medicine open to anyone, though some clinical teaching existed.

Otherwise the teachings of Hippocrates were ignored and rival

schools of medicine wrangled interminably over their various ideas. Empiricists ignored the causes of disease and concentrated solely on its cure. Asclepiades, one of the first Greek physicians to arrive in Rome, founded the Methodists, who held that disease emanated from the pores, which if too contracted or too relaxed produced ill health. Into this confusion came Claudius Galen, a physician from Pergamos in Asia Minor, who professed to follow the teachings of Hippocrates. Born in AD 129, Galen became surgeon to a gladiatorial school in his home town after an itinerant medical training. Here he received ample experience of the dreadful wounds inflicted in the arena. Four years later he sought his fortune in Rome where he quickly became famous. His success and arrogance aroused the hostility of other Roman doctors and he was forced to return to Pergamos. When, however, he was summoned by the Emperor Marcus Aurelius in AD 170 and successfully cured him of stomach ache, his future was assured. He stayed in Rome until his death in AD 199 keeping a drug-shop on the Sacred Way and practising and writing upon medicine. During this time he produced over 500 books.

Although he claimed to follow Hippocrates, Galen ignored observation. Nevertheless his theories were accepted without hesitation for the next 1,300 years. This was partly because he claimed they had the authority of Hippocrates, partly because of his dogmatic manner, and partly because they won the support of the Moslem and Christian Churches. To explain disease Galen accepted the idea of humours. To counter these if they became unbalanced he prescribed diets, massage, exercise, and drugs to cool, heat, moisten, or dry the body as required. Thus pepper would warm a sufferer and cucumber seeds cool his feverish condition. Three of his theories retarded medical development for centuries. He believed that the blood contained certain essences, the most important of which was the 'Vital Spirit' which came from the brain. He believed too that in its journey through the body it passed from the right ventricle of the heart to the left ventricle through invisible pores and that in the treatment of wounds pus was an essential agent. Although he strangled medical progress until his ideas were discredited this 'medical dictator' laid the foundations of experimental physiology. No physician, he held, should be without a knowledge of anatomy. Since human dissection was still illegal he dissected pigs and apes and unhesitatingly related

9 The Pont du Gard built by Marcus Agrippa in 19 BC. This great triple-tiered aqueduct carried water to Nîmes from springs twenty-five miles away

his discoveries to the human body. These, like his other findings, went unchallenged until the sixteenth century.

While the Roman contribution to medicine was negligible, Rome provided a world example in matters of public health. Nothing resembling her system of sanitation and water-supply and organization of medical services was again seen by Europeans until Cortés's Spanish *conquistadores* marched into the Aztec capital of Mexico City in 1519. The Romans realized that disease was caused by filth and overcrowding. The marshes surrounding Rome, a fertile breeding-ground for malaria, were therefore drained from the seventh century BC. By the sixth century Rome was furnished with a network of underground sewers including its main drain, the Cloaca Maxima. The Tiber was also replaced as a source of water-supply by aqueducts bringing pure water from miles away. By the second century AD fourteen such aqueducts supplied Rome with an estimated 300 million gallons of drinking-water a day. The poor carried it from public fountains. The affluent had it piped into their homes. Rich private houses also had hot and cold baths and swimming-pools. To allay social unrest, emperors and wealthy citizens built magnificent

public baths for the poor. The baths constructed by the Emperor Caracalla in AD 217 could, for example, accommodate 1,600 bathers at a time. By the time of the early empire Rome boasted 150 public latrines and even her most distant outposts had water-flushed lavatories and water-storage tanks.

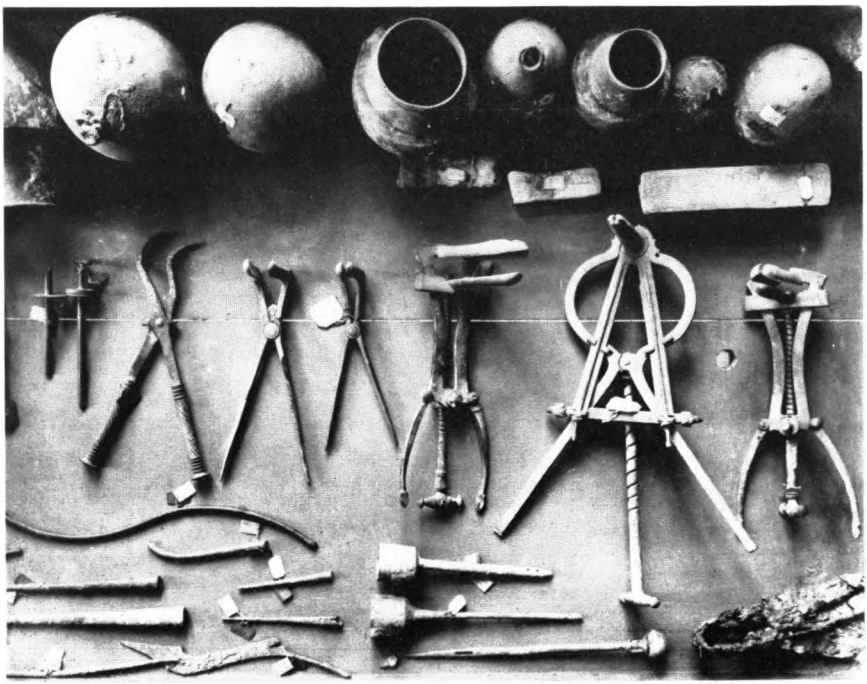
The building of Roman towns was planned. Roman architects paid attention to the position and drainage of buildings and attempts were made to supervise the storage and sale of food. Legislation maintained this system of public health and edicts regarding street cleanliness were passed as early as 450 BC. In the early empire public physicians were appointed in many towns to treat the poor, while the Emperor Vespasian provided teachers of medicine to ensure that the supply of doctors was maintained. It was in the Roman army, however, that the Roman medical system appeared at its best. Medical officers and surgeons, often Greek, existed at both legionary and cohort level in addition to orderlies and dressers. They were subordinate to combat officers and their medicine was elementary, being confined to herbal lore and natural antiseptics like pitch and turpentine. None the less, Roman field dressing-stations, like that shown on Trajan's Column, seem to have been efficient, and surgeons were also provided on Roman ships of war.

It is no surprise that a Roman hospital system was also fully developed. Private hospitals existed by the first century AD for the wealthy and for slaves. Campaign armies from the time of Augustus (27 BC–AD 14) were provided with hospitals like that at Novaesium near Düsseldorf, whose wards were built upon a corridor plan and which was equipped with refectory and offices. From military hospitals it was only a short step to public hospitals, which were subsequently founded in many parts of the empire. The hospital movement accelerated with the Roman adoption of Christianity and the charitable tradition of caring for the sick survived even the fall of Rome when all other aspects of Roman medicine were lost.

Ironically, disease played a part in the downfall of an empire whose public health practices remained unsurpassed until the nineteenth century. The slow decline of the Roman Empire resulted from a complex variety of political, social, and economic factors, but in its western parts the spread of a severe form of malaria, increased by active communication with the Orient, undoubtedly aided the process

of decay. When the Roman drainage system fell into disuse with the Gothic invasions of the late empire, the fields were transformed into swamps which became breeding-grounds for mosquitoes. Malaria, followed by smallpox, killed thousands and undermined the physical condition of countless others, thus hastening a decline in economic activity already in progress. By AD 476, the Roman Empire in the West was at an end. In the East it survived in the form of the Byzantine Empire, centred upon Constantinople, for much longer. In 542, however, this fell victim to the Plague of Justinian, the first major historically known pandemic of bubonic plague. Beginning in Egypt, whence it had come via the trade-routes from China, it spread along the North African coast through Palestine and Syria to Europe. At its peak it affected the whole of the known world and the death-rate reached heights hitherto unknown. When it died out at the end of the century half the population of the Eastern Roman Empire had perished either from the disease or from destitution during these nightmare years. Byzantium lingered on but the enervating effects of the plague were similar to those of malaria in the West.

10 A selection of Roman surgical instruments discovered at Pompeii



3 Medieval darkness

AFTER THE ROMAN EMPIRE had been overrun by the barbarian Goths and Visigoths, Europe was left inhabited by loose Teutonic tribal groups. Its new rulers were an agricultural people unused to city life. Roman standards of health vanished. Europe ceased to be a centre of learning and its civilization and medicine decayed. From the fifth century until the medical renaissance of the sixteenth century, no progress was made in medical knowledge or practice. Germanic medicine was a blend of pagan magic, superstition, and herbalism combined with such vague elements of Greek and Roman learning as had reached the Teutonic peoples. The Anglo-Saxon settlers of Britain regarded Woden, father of the gods, as the bringer of good health. Illness was the work of the nine venoms, the nine diseases, or of 'worms', elves, and witches. It was countered by charms and incantations or by the herbal lore found in Anglo-Saxon leechbooks, some of whose cures have descended into more recent folklore. The Anglo-Saxon leech had a wide knowledge of plants and garden herbs.

Some herbal remedies were effective but the Anglo-Saxons lived in filthy conditions combined with a total absence of sanitation and personal hygiene. The chronicles of the sixth to the tenth centuries are filled with references to epidemics of smallpox, dysentery, typhus, and plague. These, together with recurrent famines, paved the way for the Danish conquest of the early eleventh century. In this Dark Age medicine eventually passed into the hands of the Christian Church and Arab scholars.

In some respects the early Christian Church hindered the progress of medical science. It dominated intellectual life and gave more thought to the hereafter than to earthly problems. Physicians were denied the power of healing lest they should detract from the 'Great Healer'. James had recommended prayer to help the sick. Prayer and fasting were, therefore, considered the best remedies for illness which was a punishment for sin or the work of demons. In AD 391 a mob of

11 Ninth-century carving on a book-cover of Christ healing the leper and the blind man

religious fanatics burnt the great library at Alexandria which contained so much irreplaceable knowledge of the pagan past. Since the human body was held sacred as the image of Christ, dissection was forbidden and anatomy and physiology died except in the erroneous pages of Galen. Priests again became healers employing exorcism

and holy relics to cure the sick. Maladies and parts of the body were believed to each have a patron saint who could cure and inflict disease. Ague or fever was St Pernel's disease, leprosy was St Gete's disease, plague was St Sebastian's disease, while St Fiacre was concerned with piles. The relationship was determined by the manner in which a saint was martyred. St Apollonia had her teeth knocked out and her jaw broken. Hence prayers were directed to her to relieve toothache. In these circumstances medicine could not progress. Nevertheless the Church compensated for its temporary intolerance of medicine by its unstinting care of the sick. 'Care of the sick', states the *Rule* of St Benedict, who founded the great Benedictine Order in 527, 'is to be placed above . . . every other duty, as if indeed Christ was being directly served by waiting on them.' Other Orders imitated and most monasteries had their infirmary and herb garden which enabled them to tend their own sick brethren and members of the general public. The translation and transcription of ancient manuscripts was another monastic occupation. The manuscript works of classical physicians had passed into the keeping of the Church, to which posterity was indebted for their preservation and circulation before the coming of the printing-press.

The second great early medieval repository of medical knowledge was the Moslem Arab Empire, which spread rapidly across the Middle East in the sixth century after the death of the Prophet Mahomet and which by AD 1000 extended from Spain to India. The Arabs were more tolerant of other creeds and races than the Christians. They were also as eager for knowledge as for conquest. Classical learning was revived and translated into the common imperial language of Arabic. In this rich cosmopolitan civilization, which amazed the uncultured Frankish Crusaders of the eleventh and twelfth centuries, medicine, which had reverted to magic in the West, experienced a revival.

Arab physicians discovered much about epidemic fevers and Eastern eye complaints. Their principal contribution, however, was in the field of pharmacology where developments were aided by their excellent knowledge of chemistry. The word 'drug' is of Arabic origin. Among the new drugs used by the Arabs were benzoin, camphor, the sedative laudanum, and the purgative senna. The Arabs also continued the Roman system of hospitals. There were

famous teaching hospitals at Jundi-Shapur and Baghdad, Damascus and Cordova. The Mansur hospital in Cairo, finished in 1284, had separate male and female wards and specialist wards for gynaecology, wounds, eye complaints, and fevers, the last wards being cooled by fountains. The hospital also possessed courtyards for lectures, its own herb garden, dispensary, and library. To aid recovery fifty speakers constantly recited the Koran, story-tellers amused the patients, and soft music was played at night to lull insomniacs. Patients were admitted regardless of race, creed, or social status. Upon departure they were given sufficient money to cover their convalescence.

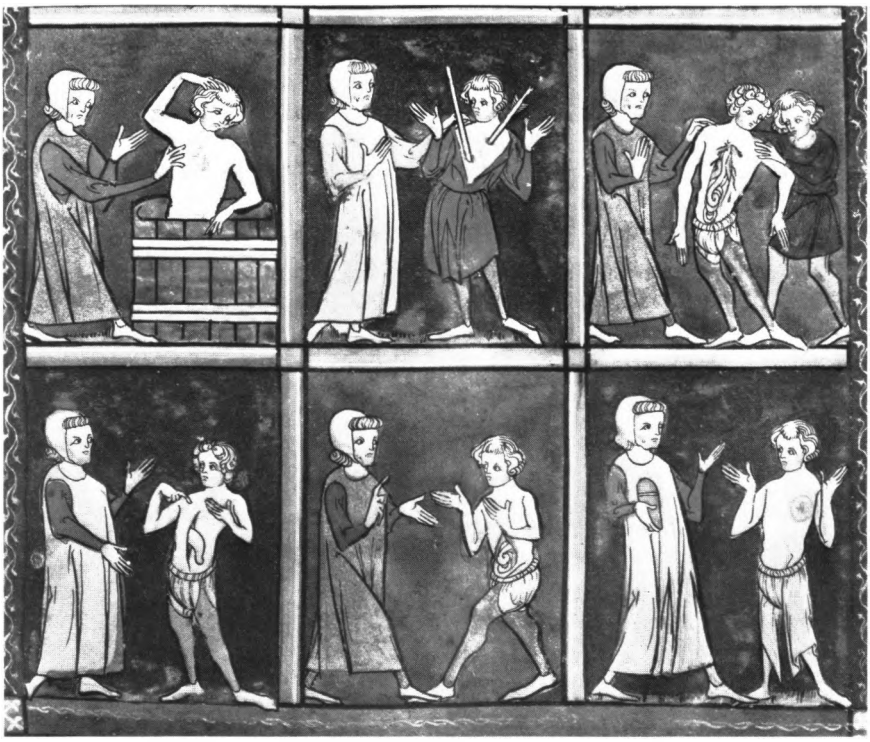
Arab physicians-in-ordinary and court physicians enjoyed high salaries. If their treatment failed, however, they were liable to the lash, imprisonment, or death. One of the greatest physicians that Islam produced was Rhazes, the 'Arab Hippocrates'. A former musician and philosopher, he did not begin medical study until he was forty, after he had seen the human misery of the sick-house at Baghdad. Here, in 918, he founded a hospital after choosing a site

12 Scene from a twelfth-century Herbal. The centaur Chiron offers the herb centaury to a physician. The worm below is put to flight. Centaury was considered a tonic

by hanging pieces of meat in various parts of the city to see where putrefaction was longest delayed. A prolific writer, he produced some 150 books including a medical encyclopaedia weighing 22 lb. Like Hippocrates, he based his diagnosis upon observation of disease. His major contribution was to distinguish between smallpox and measles, the two great endemic diseases of the Arab world. The zenith of Arabic medicine is represented by his fellow Persian, Avicenna (980–1037), an infant prodigy, who became a court physician at eighteen. He believed firmly in the medieval idea that all medical knowledge had culminated in the Greek masters and nothing could be added to what was already written. Since knowledge of medicine, like knowledge of the Bible and the Koran, was fixed for all time, he set out to codify all ancient medical authorities into one huge work to help physicians. From the twelfth to the seventeenth centuries his *Canon of Medicine* was accepted in all European universities as the most authoritative medical textbook.

As anatomy was still based upon Galen and it was considered unclean to touch the human body with the hands, the Arabs were not well versed in surgery. Most surgery was divorced from medicine and left to inferior lithotomists and cataract-gougers. Nevertheless, Rhazes was probably the first to use sutures of animal gut for sewing up wounds. Albucasis of Cordova (936–1013), which with its fifty hospitals had by the tenth century become the great centre of Arabic medicine, also produced a textbook of surgery containing illustrations of surgical instruments and appliances. These included the cautery, a red-hot iron applied, usually with disastrous results, to wounds and septic ulcers to burn out the poison. 'Surgical operations', Albucasis remarked, 'are of two kinds, those which benefit the patient and those which kill him.'

A profitable union of the medical knowledge of both the East and West was effected at the seaside town of Salerno, south of Naples, in the ninth century. Here a cosmopolitan medical school began which was the first of its kind in Europe. Traditionally founded by a Jew, a Roman, a Greek, and an Arab it was open to men and women of all nationalities and beliefs. Since it was not a Church school it was free to teach medicine upon a sound basis. The Norman Duke, Roger Guiscard, captured Salerno in 1076 and made it his capital, and encouraged medical study. During the Crusades



13 Scenes from the eleventh-century manuscript of Roger of Salerno's book *Chirugio*. The patient top left has broken ribs, and the one bottom right a 'phlegmatic abscess'

it became a convalescent centre for wounded Crusaders and reached its height in the eleventh century. By the twelfth century it had its own highly organized curriculum upon which students were examined and awarded degrees, thus becoming the first true doctors. Anatomy and surgery were taught, although the former was still based upon animals. The seed which later flowered in the Renaissance was sown at Salerno. By the thirteenth century there was also a medical school at Naples and others in the new European universities at Montpellier, Bologna, Padua, Paris, Oxford, and Cambridge.

Henri de Mandeville (1260–1320), lecturer in anatomy at Montpellier, was a progressive surgeon who contrary to popular belief urged cleanliness and dryness in the treatment of wounds and an expert knowledge of medicine for surgeons. 'God', he stated, 'did not exhaust all his creative power in making Galen.' Guy de

14 'The Doctor of Physick' from an early manuscript of Chaucer's *Canterbury Tales*

Chauliac (1300–68) the best-known surgeon of his day, who was educated at Montpellier, Paris, and Bologna, attempted to base surgery upon anatomy. Like other medieval surgeons he anaesthetized his patients with a soporific sponge soaked in opium, mandrake, and henbane. Its fumes were inhaled and part of its contents probably swallowed.

In general, however, there was little advance on past knowledge. Ecclesiastic and scholastic opposition was too strong. Medieval schoolmen based their knowledge upon abstract theory rather than practice. Despite the pleas of the thirteenth-century Franciscan friar, Roger Bacon, experiment was regarded as dangerous for the soul since the misguided researcher could be entrapped by the devil. Hippocrates and Galen remained the unquestioned authorities. Medical teaching was oral since books were few. At the end of the fourteenth century, the Paris medical school had only twelve. Those that existed were largely Arabic translations. Dissection was rare. When the University of Tübingen secured the right to dissect an

executed criminal every three years, the scholars, physicians, and students who participated saw only a superficial examination of the thorax and abdomen.

The medieval European surgeon's activities were limited to court nobility, the higher clergy, and rich merchants. Other patients and minor operations were left to ignorant barber-surgeons, who combined the cutting of hair with blood-letting, abscess-opening, tooth-pulling, and sometimes even amputation. The white pole upon which they wound and carried their blood-stained bandages became their trade-mark and has descended to barbers today. Fierce rivalry existed between surgeons and barber-surgeons. In rural areas, where neither penetrated unless summoned by a wealthy patient, the poor secured help only from travelling quacks who collected a fee if successful and fled for their lives if not. The unfortunate quack who failed to cure the blindness of King John of Bohemia was tied in a sack and flung in the River Oder.

The state of medicine was little better. Geoffrey Chaucer, the English poet, paints an almost complete picture of the state of medieval medicine in his portrait of a 'Doctor of Physick' in *The Canterbury Tales*, written in about 1387. The Doctor depicted was probably his contemporary John of Gaddesden, who studied at Montpellier and later taught at Oxford. This 'verrey parfit praktisour' was not a man to waive his high fee. A cautious spender he 'kepte what he won in pestilence' and was in fruitful collusion with the apothecaries who dispensed his medicines. He prescribed drugs liberally, talked plausibly about the Greek and Arab doctors, and relied heavily upon the humours theory and astrology. The latter forbade him to compound his herbs except when the moon was favourable. Like all doctors he would not operate or even draw teeth if the heavenly bodies presaged evil. The real John, a fashionable practitioner, was the first Englishman to hold the position of Court Physician. He made his mark when he cured Edward II's son of smallpox by robing him in scarlet and confining him to a room hung with red drapes. In this case practice preceded theory. Only centuries later did Finsen discover that smallpox blisters do not form when light is excluded. John's principal skill lay, however, in his 'good judgement of how far mankind could be imposed upon'. He took care to invent the dearest medicines for his credulous rich patients and prescribed

twice the quantity given to the poor. He even went so far as to publish a list of illnesses financially beneath his notice. The treatments recommended in his *Rose Angelica* do not inspire confidence. To cure tonsillitis he recommended hanging the beak of a magpie round the neck. For toothache he prescribed the touch of a needle which had pricked a wood-louse. These remedies were no further advanced than those of ancient Egypt, and show the total poverty of medical science in the Middle Ages.

The most important achievement of medieval medicine was the continued development of hospitals. Although the Church hindered scientific medical progress it still constantly encouraged the care of the sick. St Bartholomew's, the oldest British hospital, was started in 1123 by Rahere, Court Jester to Henry I, when he founded a religious Order. St Thomas's Hospital, the second oldest, was opened in 1213 by Richard, Prior of Bermondsey, against the wall of his monastery. Many other European hospitals were also ecclesiastical foundations. Some were large and well ventilated with tiled floors, separate cubicles for patients, and adequate water and sanitation. Others were smaller lazar and pest-houses. Most of the work was performed by monks and nuns until the fourteenth century, when the administration of hospitals passed from the Church to the municipalities and many became lay institutions.

If the Roman tradition of hospitals continued, the Roman tradition of public health and personal hygiene remained lost. Insanitary and overcrowded walled towns and squalid rural settlements were hotbeds of disease. Skin diseases were rife owing to personal uncleanliness and a surfeit of salted meat and fish eaten with comparatively few vegetables. Famine and population movement arising from countless wars accentuated the problems created by ignorance. Typhus, the winter disease, often written off as 'plague', flourished with the custom of wearing the same underclothing and, therefore, carrying the same fleas from Michaelmas to Lady Day. Ergotism, or 'bread madness', a strange epidemic disease with spasms, violent pain, gangrenous sores, and a high mortality was caused by a fungus on rye and arose from eating inferior black rye bread. The age-old disease of tuberculosis remained endemic in conditions of medieval poverty and food shortage. Tuberculosis of the neck, known as scrofula, or the 'King's evil', was particularly common. In England

15 Scenes in a fourteenth-century French hospital

the king's touch was regarded as the principal remedy and Edward I 'touched' 543 persons in one month in 1277. Smallpox, which had raged in Italy and France during the sixth century and spread to Spain from Egypt in 714, was again brought to Europe by returning Crusaders in the thirteenth century. By 1306 it had even been carried by Danish ships to distant Iceland, where there were no fewer than twenty epidemics. Malaria, too, was disseminated throughout Europe by Crusaders where it long continued in an endemic form.

The two greatest medieval diseases were, however, leprosy and the bubonic plague. The former ravaged practically every European country in the middle and later medieval period. Although the Crusades and more lively communications may have helped its spread, it had already been brought from Asia, perhaps by Roman soldiers, in the early centuries of the Christian era. By the eighth to tenth centuries it was widespread in southern Europe. Not only was it one of the few diseases recognized as being contagious but lepers were

16 A leper carrying clappers and a begging-bowl is met at the gateway of a French leper-house

believed to have transgressed against God. Therefore they were vigorously isolated from the community, proclaimed dead as citizens, forbidden marriage, and ordered to wear a distinctive black cloak with white patches. Where possible they were herded into leper-houses outside town boundaries. In 1200 there were some 19,000 leprosaria in Christendom. By 1400 France and Germany had 10,000 between them. On special days lepers were permitted to eke out a wretched living by begging from house to house, sounding clappers, horns, or a bell to warn of their approach. Objects given them were attached to the end of a long stick which they carried for this purpose. The low side windows frequently built into medieval parish churches are believed to have been for lepers to witness the Sacrament without entering the church. Upon several occasions they were accused of a conspiracy to control the world by spreading infection. In 1313 King Philip the Fair wanted to burn them all. This effective if drastic remedy was forbidden by the Church. Towards the close of the fourteenth century, however, leprosy, whose bacilli are spread by the breath or by fleas and body lice, began to disappear as a disease of major importance. This was partly because so many

lepers were wiped out by the Black Death which in the mid-fourteenth century shook the foundations of the civilized world.

The term 'Black Death' was first used in the seventeenth century to describe the appearance of the body after death when haemorrhages beneath the skin gave the corpse a dark, mottled hue. Only in 1905 was it discovered that it is primarily a disease of rodents, particularly the black rat, and human epidemics arise from contact with infected rats, usually through their fleas, in which the plague bacillus grows. About three-quarters of all cases are of the bubonic type. Sudden shivering, headache, vomiting, and pains in the abdomen and limbs are followed by delirium. Large and painful boils appear in the body joints and unless treated the disease runs its fatal course in five days. Even more deadly are two variants caused by the same organism – pneumonic plague, which is highly contagious since it affects the lungs, bringing death within three days, and septicaemic plague in which the flea injects the bacillus directly into the blood stream causing death within twenty-four hours. Recovery from bubonic plague was possible. From the other forms it was rare. In the terrible visitation of the fourteenth century the plague occurred simultaneously in all its three forms.

The source of the outbreak has been located as Lake Issyk-Koul in Central Asia. A natural disaster, possibly a flood, drove a host of rodents from their lakeside homes. With them travelled fleas infected with the plague bacillus. As the rodents died these first found human hosts in China where records report 13 million deaths. Travelling along the trade-routes from China, with the black rat providing porterage, the plague reached India in 1325. Moving westwards it passed too into Asia Minor and thence to Egypt and North Africa. By 1346 it had also infected a Tatar army besieging the Genoese trading port of Kaffa in the Crimea. Knowing their own fate was sealed the Tatars catapulted their plague-infested corpses into the the town. As plague broke out the Genoese took to their ships and fled homewards:

> At the beginning of October . . . 1347, twelve Genoese galleys . . . entered the harbour of Messina in Sicily. In their bones they bore so virulent a disease that anyone who even spoke to them was seized by a mortal illness . . . The citizens expelled them from . . . the harbour. But the evil remained in the town and caused a fearful outbreak of death.[1]

[1] Frau Michele de Piazza, *History of Sicily 1337–1361*

After ravaging Messina the epidemic overran Sicily. Meanwhile ships fleeing from Messina in January 1348 sailed up the coast of Italy and the same ghastly sequence of events was repeated as sailors abandoned their vessels and carried the plague into the ports. A helpless continent lay before them, where bad harvests had reduced men's slight resistance to disease. By the close of the year northern Italy, Sardinia, Corsica, Spain, and France were in its grip. In 1349 it passed to the rest of Europe and Hungary, Germany, and the Netherlands were overwhelmed in turn. In August 1348 a shipload of refugees from Calais sought refuge in the plague-free island of Britain. Their ship docked at Melcombe Regis, Dorset. By December south-west England was stricken and by 1350 plague had reached Scotland and Ireland. An infected ship from London, most of whose crew were already dead, ran aground near Bergen bringing the disease to Scandinavia and the Baltic. From there it wrought havoc in Iceland and Greenland and in 1352 swept eastwards through Russia to complete its circle of death.

All were agreed that the immediate cause was corruption of the atmosphere. Some considered that foul vapours, created by Jupiter, had forced their way from the earth during earthquakes in southern Europe or that the infection arose from the decomposing corpses of a plague of locusts. The most popular belief, however, was that plague came from invisible arrows shot by Christ. Behind all these explanations lay the wrath of God. Preventions and cures were equally varied. 'Go quickly, go far', was the advice of most plague tracts, which helped to spread the infection rapidly. Where flight was impossible emphasis was placed upon purification of the air. The rich burned aromatic woods and powders as recommended in the Bible and carried sweet-smelling pomanders of cloves, rosemary, lavender, and thyme. Church bells were rung to move on the stagnant atmosphere, while Pope Clement VI spent a hot Provençal summer seated between two huge fires. His remedy, despite its discomfort, was more useful than most since the plague bacillus cannot live in extremes of temperature. Violent activities like love-making, anger, and hot baths were to be eschewed while half an hour daily inhaling the contents of a medieval latrine was believed to strengthen the resistance upon the grounds that bad expels bad.

The effect of this inexplicable calamity on a superstitious peasantry

17 Basle 1349. Ecclesiastics hurriedly give the blessing to plague victims. Here, the Jews were blamed for the Black Death which killed some 14,000

produced a mixture of violent hysteria and fatalistic gloom. Those universal scapegoats the Jews were persecuted since it was rumoured they had caused the plague. A wave of anti-Semitism swept Switzerland and Germany. In Basle all Jews were penned in wooden buildings and burned alive. Some 16,000 perished in Strasbourg and 12,000 in Mainz. From Hungary and eastern Europe wild bands of Flagellants, or Brothers of the Cross, moved from town to town scourging each other until the blood ran over their ankles in an attempt to appease the wrath of God. When they began to threaten what remained of organized government, however, they were broken up. Once the disease was caught there was nothing to be done save bleed the patient, clap plasters on his boils, including one made of gum resin, white of lilies, and human excrement, and await the coming of death. The Italian author Boccaccio, who survived the pandemic, wrote:

> The condition of the people was pitiable to behold . . . they sickened by the thousand daily and died unattended and unsuccoured. Many died in the open street; others dying in their houses made it known

that they were dead by the stench of their rotting bodies. Consecrated ground did not suffice for the burial of the multitude of bodies which were heaped by the hundred in vast trenches like goods aboard ship, and covered with a little earth. . . .[1]

At Avignon, the Pope consecrated the Rhône so that corpses could be flung into its depths. At Venice scores of ships transported bodies to a deserted island in the lagoon.

Ironically, Italy, which boasted the best European medical schools, suffered most heavily. This was perhaps because the Pope advanced the Holy Year, due to be celebrated in 1350, to 1348 in order to appease the Heavens, thus bringing 150,000 pilgrims from all over Europe to Rome. For Agnioli di Tura of Siena, who buried five of his children with his own hands in a single grave, it was 'the end of the world'. Devastation in Florence was so great that the Black Death is often referred to as the 'Plague of Florence'. None the less, it was the Italian city states, each able to enforce its own laws, which came nearest to a solution in the form of isolation. With the arrival of the plague at Messina, neighbouring Catania closed its gates to refugees – acting upon the principle of the popular prayer 'Our Father, let the pestilence fall on others.' Pistoia forbade its citizens to visit or return from neighbouring states. Milan bricked up the doors and windows of infected houses with the luckless victims inside, while the port of Venice introduced the earliest form of quarantine. Christ had spent forty (*quaranta*) days and nights in the wilderness. Therefore, Eastern traders were isolated upon a near-by island for a similar period before being admitted to the city. In many cases these regulations were enforced too late to be effective but were repeated with greater success at Venice, Milan, and Ragusa when plague returned in the 1370s.

By the mid-1350s nowhere remained untouched. Bohemia, the Pyrenees, and large parts of Poland escaped more lightly since the black rats moved on because of food shortage, or were driven out by indigenous brown rats. Total mortality is difficult to assess. It has been estimated that 23 million perished in the East and a further 25 million in Europe. In the latter, the towns suffered more heavily than the countryside – 14,000 died at Basle, 16,000 at Strasbourg, 40,000 at Vienna, 50,000 in Paris, and 100,000 in London. From January to April 1348, 62,000 corpses were recorded buried at

[1] Boccaccio, *The Decameron*

Avignon alone. Medieval statistics are notoriously misleading and speculative. Nevertheless it seems likely that something like a third of the total European population succumbed. One recent estimate reduces this figure to a tenth, but whatever the total the social and economic consequences of the plague brought society to the verge of collapse. Trade and agriculture ceased, with fields untilled and crops unharvested. Beasts died untended and famine resulted. Moral ties vanished. In the wild scramble for safety mother fled from child, brother from brother, and husband from wife. Villages were deserted, some never to be reoccupied, and grass grew in the streets. Empty houses were plundered and many sought the joys of the flesh while they could. The Church, bereft of its best clergy, took long to recover. Iceland and Greenland were almost depopulated and their scattered Norse communities, left without supplies from Scandinavia, died out. In Split, wolves came down from the hills and fell upon the survivors. The Hundred Years War between England and France was temporarily halted as were building works upon churches and cathedrals. More permanent were the effects of the labour shortage resulting from the huge death-roll. In England some manorial lords were forced by labour shortage to rent out demesnes which they had insufficient villeins to farm or else they changed from arable to pastoral farming, requiring less labour. Other lords freed their villeins for cash payments and hired wage-labourers to farm their lands. When these demanded higher wages because of the labour scarcity the government attempted to restrict them, thus causing the Peasants' Revolt of 1381.

The outbreak of 1347–50 was by no means the last in medieval Europe. There were four further outbreaks before the close of the century and the fifteenth century was again punctuated by visitations involving many deaths. In the absence of any effective antidote it is small wonder that 1374 saw the beginning of an extraordinary mass emotional disturbance known as 'St Vitus's Dance' or the 'Dancing Mania', which began in Italy and spread to all parts of Europe. Wild screaming hordes suddenly began to dance for hours or days without reason with eyes staring, mouths foaming, and faces contorted, until they collapsed exhausted. As some fell others took their places. Music was the only cure. When an outbreak occurred it was the village musicians who were summoned and not the doctors. The epidemic

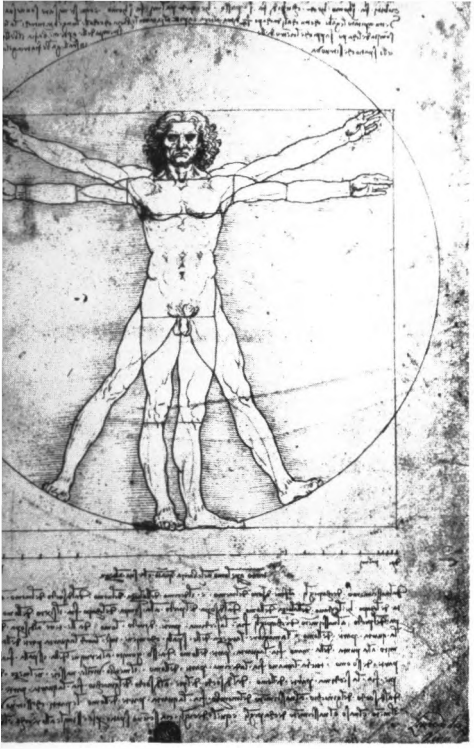
represented the release of the pent-up emotions of those who had suffered mentally and physically to the limits of human endurance. Gradually, however, the will to live re-awoke and the birth-rate began to rise. The Black Death of the Middle Ages, the most terrible visitation upon a world scale that man had known, was not, however, forgotten and fear of the plague was one important factor which helped to stimulate a revival of medical learning in the Renaissance era which followed.

18 Sufferers from St Vitus's Dance accompanied by their musicians on a pilgrimage to St Willibrod's Church, Epternacht, near Luxembourg

4 The Renaissance era

MAN'S CONTINUING HELPLESSNESS before disease was re-emphasized by the onset of 'the English Sweat' or 'sweating sickness' which first occurred in England in 1485 following the Wars of the Roses. Beginning among Henry Tudor's army, which won him the throne at Bosworth, it spread so rapidly that in London the Coronation was postponed and two Lord Mayors died within a week. Attacks lasted only twenty-four hours and brought 'a grete swetyng and stynking . . . and a contynued thurst with grete hete'. Nevertheless mortality was so high that more Englishmen died than in the preceding thirty years of civil conflict. Further outbreaks occurred in 1508, 1517, 1528, and 1551. In the 1528 outbreak the sweat spread to Hamburg and thence via Germany and the Netherlands to Scandinavia and Russia where thousands perished. The final visitation began at Shrewsbury in the spring of 1551 where it claimed 900 victims in a few days. After this it vanished as mysteriously as it had come. Its nature has never been satisfactorily explained. Probably it was a virus infection allied with rheumatic fever and associated with lack of personal cleanliness.

Fear of death, however, was not the only factor involved in the revival of medical studies. The Renaissance, beginning in fourteenth-century Italy, revived not only the classical culture of ancient Greece and Rome but also Greek concern with man's life in this world rather than the next. Scholars and thinkers strove to escape the limitations of the medieval Church upon thought and experiment. Gradually the new enlightenment spread from Italy across western Europe. The Renaissance with its classical emphasis also produced a new attitude towards the human body, the beauty of which again became appreciated. Great Renaissance artists such as Michelangelo, Raphael, Dürer, and Leonardo da Vinci (1452–1579), began to practise dissection in order to draw the human form accurately. The last-named in particular made numerous drawings of human bones,



19 Drawing of Leonardo da Vinci showing the proportions of Man according to Vitruvius

20 Andreas Vesalius, the Flemish anatomist who revealed the errors of Galen

muscles, and internal organs. These were intended for publication in a great book on anatomy in conjunction with the Pavian Professor of Anatomy, Marco Antonio della Torre. Della Torre's death, however, prevented its production and instead Andreas Vesalius (1514–64) became the leading Renaissance anatomist.

Vesalius came from a Brussels medical family of long standing. His father had been Apothecary to the Habsburg emperor, Charles V. At the University of Paris, where he studied medicine, his teacher, Jacobus Sylvius, was a strong believer in Galen and ascribed any new features in the human body revealed by dissection to changes which had occurred in human anatomy since Galen's time. Vesalius was unconvinced and pursued his own dissections using corpses which he snatched from the gallows under cover of darkness or bought secretly from grave-robbers. In each corpse he dissected

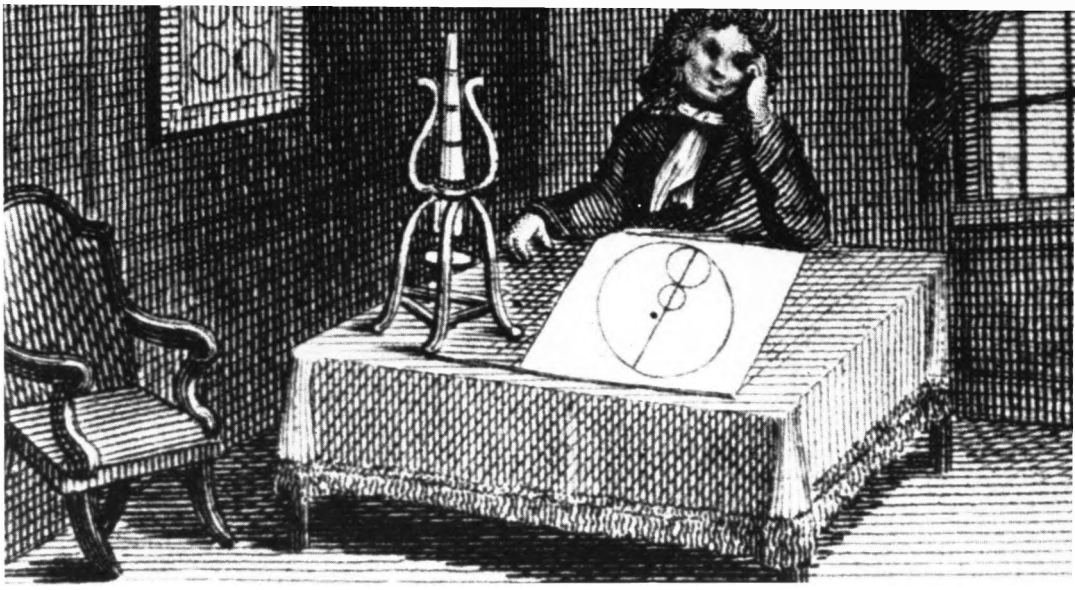
the structures appeared the same, yet they were not as Galen had described. In 1537 Vesalius became Professor of Surgery and Anatomy at Padua University, where four years later he found the answer to the mystery. While dissecting a monkey he discovered a small projection of bone upon one vertebra of its spine. Galen had described such a feature and yet Vesalius had never found it upon human bodies. There was only one answer. Galen's dissections had been carried out upon animals although for centuries men had believed that he was describing the human anatomy. In 1543 Vesalius published his great book on the working of the human body, *De Humani Corporis Fabrica*. Illustrated by over 300 woodcuts this showed clearly that most of Galen's anatomy was based upon that of animals. If Galen had erred here he could have done so elsewhere. There was, therefore, good reason for re-examining the ancient authorities and experimenting for oneself. Such, however, was the opposition Vesalius incurred that he resigned his post at Padua. At the age of thirty he was finished as an anatomist. Instead he became Court Physician to Charles V and later to his son Philip II of Spain. He died tragically in a shipwreck in 1564 while returning from a pilgrimage to Jerusalem which had been ordered by the Spanish Inquisition to atone for the death of a noble patient who had shown unfortunate signs of life while Vesalius was performing a post-mortem examination upon him.

Although Vesalius had revealed the weaknesses of Galen's anatomy he made little attempt to discuss the physiology or working of the human body, and it was not until 1628 that the Englishman William Harvey showed conclusively that the blood is circulated through the body by the action of the heart.

Born in 1578, Harvey studied at Cambridge before graduating as a Doctor of Medicine at Padua in 1602. Returning to England he secured a London practice and ultimately became Royal Physician. He noted that in the arteries the blood always flowed away from the heart and in the veins it always flowed towards it, the valves preventing it from changing course. He also calculated that two ounces of blood passed with each heartbeat into the arteries. With a heart beating seventy-two times a minute, 270 lb of blood passed into the arteries in half an hour. Only if the same blood was pumped time and time again through the heart could the amount of blood needed possibly be available. In his *De Motu Cordis* of 1628 he therefore argued

21 The English physician William Harvey demonstrates to King Charles I and the young Prince his theory on the circulation of the blood

that the heart was a pump sending the same blood into the arteries and back through the veins. After passing through the lungs for purification it was then pumped round the body again. Only one stage in its circuit evaded Harvey. Because the capillaries were too small to be seen by the naked eye he never discovered how the blood passed from the arteries to the veins. This was left to the Italian Marcello Malpighi (1628–94) and the Dutchman Antony van Leeuwenhoek (1632–1723). Both used the microscope, an invention probably known to the ancient world but improved by Zacharias Jansen, a Dutch spectacle-maker, who made his first microscope in 1609. Malpighi first saw the capillaries in 1661. Leeuwenhoek, a Delft merchant, with leisure to build over 200 microscopes which magnified up to 270 times, used them to see for the first time the red corpuscles of the blood. In the scales he scraped from his teeth he also witnessed in 1675 'little animals more numerous than all the people in the Netherlands and moving . . . in a most delightful manner'. These were the bacteria which cause decay. Although it was not yet realized, germs, the creators of disease, were now visible. Other microscopists followed as attempts were made to place medical knowledge upon a more scientific basis.



22 Antony van Leeuwenhoek, the Dutch merchant and naturalist with one of his many microscopes

The Renaissance also brought progress in surgery, where the major problems were still bleeding, pain, and infection. While operations and instruments remained much the same as at the close of the Middle Ages, the sixteenth-century surgeon's problems were intensified by the invention of gunpowder. New instruments were necessary to extract bullets and new techniques needed to curb the virulence of gunshot wounds. The large leaden bullets of the day with their low velocity created gaping holes partly blocked with bits of filthy clothing and armour. Blood-poisoning resulted, creating the belief that all gunshot wounds were poisoned. Soldiers had their own rough and ready remedies, one of which was a drink of gunpowder stirred in water. Surgeons, however, believed that the poisons must be burned out. For centuries warm oils made from the seeds of various plants had been used for treating wounds. Now boiling oils were used or the patient, stupified by alcohol, was held down and cauterized. While such treatment stopped bleeding, its usual result was agony and death. The principal training-ground for the surgeon was still the barber's shop or the battlefield, where, in the absence of any organized medical service, a host of barber-surgeons, irregular practitioners, and women skilled to suck and dress wounds followed the armies.

The outstanding Renaissance surgeon was Ambroise Paré (1510–90). The son of a barber-surgeon from Laval, Paré understood neither Latin nor Greek, unlike fashionable practioners of his day. Nevertheless, after four years' study at the Paris hospital, the Hôtel-Dieu, he acquired the Diploma of Barber-Surgeon. The best prospects for a young surgeon lay with the army and for the next thirty years Paré accompanied the French armies in the protracted Italian Wars, which involved him in campaigns in France, Italy, Germany, and Flanders. Here, often under fire, he made his surgical discoveries at first hand.

Paré's first encounter with the harsh realities of war was at the capture of Turin by the French king, Francis I, in 1537. At Turin, Paré also discovered accidentally his greatest contribution to surgery. Casualties were so great that his supply of boiling oil ran out. To dress the remaining wounds he concocted a poultice of egg-yolk, oil of roses, and turpentine.

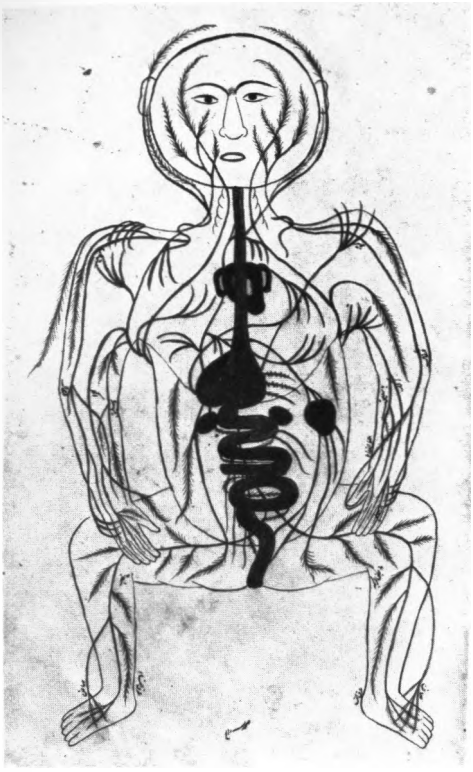
> That night I slept badly. I was afraid that the ones I had not cauterized would be poisoned. I got up at daybreak and visited them. Much to my surprise, those to whom I had applied my lotion had had a good night, they had little pain and their wounds were not inflamed or swollen. Those who had been treated with boiling oil were feverish and in pain, their wounds swollen. . . . When I had many times tried this . . . I thought . . . that neither I nor any other should ever cauterize any wounded with Gun-shot.[1]

In addition to a new treatment of gunshot wounds Paré also rediscovered that it was preferable to tie bleeding vessels with a ligature rather than to employ cautery. He invented special forceps for the seizure of arteries and new techniques for fractures and dislocations. He also attacked the physician's use of popular medicines such as powdered mummy, imported from Egypt, which was highly prized as a remedy for 'inward bruise'. Paré's surgical eminence was only grudgingly recognized by his fellow surgeons in his lifetime. He angered them by writing in French and not Latin and upset physicians by presuming to speak upon the treatment of fevers. He had never attended a medical school yet he became Europe's greatest surgeon and Surgeon to four French kings.

[1] Stephen Paget, *Ambroise Paré and his Times*

23 Ambroise Paré at the siege of Metz, 1552. Here for the first time he is employing the Greek ligature to stop bleeding

While Paré was improving the primitive surgery of his day a parallel quest for improved medical treatment was led by Paracelsus (1490–1541), son of a Swiss country doctor. After twelve years of study and travel he began his teaching career at Basle University by publicly burning the books of Galen and Avicenna. 'My beard', he stated, 'knows more than you and your writers.' The remainder of his career was punctuated by similar controversial outbursts which ultimately forced him to leave Basle and go on his travels again. His belief in such things as weapon salve and the doctrine of similars was typical of the superstition of his age. In the former, ointment was applied to the weapon that caused a wound and not the wound itself. In the latter the cyclamen plant, for example, was used to treat ear complaints because its leaf was shaped like the human ear. Nevertheless, Paracelsus also insisted upon experiment. He attacked the medical complacency of the day and simplified the complex ointments, drugs, and plasters used by doctors. Laudanum, mercury, iron, and mineral baths were among the treatments he introduced and he eventually gained a remarkable reputation in many European cities. His con-



24 Diagram of the blood system from a Persian manuscript dated 1672

viction that there must be a breach with the past helped pave the way for the numerous attempts to place medical knowledge upon a scientific basis during the scientific revolution of the seventeenth century.

The seventeenth century, the culmination of the Renaissance, was an age of intensive intellectual activity in many spheres. Observation and experiment became the accepted methods of inquiry into nature's secrets. The Accademia dei Lincei, which included Galileo among its members, was formed in Rome in 1603. Other scientific societies appeared in Germany and Italy. Most famous of all, however, was the Royal Society of London established by a Charter of Charles II in 1662. New ideas and discoveries flourished. Harvey's contribution was undoubtedly outstanding but his work was extended by four young Oxford scientists who helped in the formation of the Royal Society. Harvey had shown how the blood circulated but had provided no explanation as to why this occurred. The answer was provided, step by step, by Robert Boyle (1627–92), Robert Hooke (1635–1703), Richard Lower (1631–91), and John Mayow (1643–79).

Boyle, son of the Earl of Cork, proved by experiments with air-pumps that a mouse or bird could not live without air, which was essential for life and combustion. Hooke, Boyle's assistant and a leading microscopist, immobilized the lungs of a dog and kept it alive by blowing air into them with bellows. This first demonstration of artificial respiration indicated that it was the air in the blood rather than the movement of the lungs which was so important for life. Lower, a Cornishman, in repeating Hooke's experiment noticed that the dark venous blood was transformed into bright red arterial blood as it passed through the lungs and concluded that something in the air was responsible for the change. This element was identified by his fellow Cornishman, John Mayow, as *spiritus nitro aereus*, better known as oxygen, although it did not acquire this name until re-discovered by Joseph Priestley over a century later.

This work was carried to its logical conclusion by the curate Stephen Hales. By inserting pipes into the veins and arteries of animals he was able to measure blood pressure. Lower even attempted to perform blood transfusions. A transfusion from one dog to another in 1665 at Gresham College, described by the London diarist, Samuel Pepys, was relatively successful. An attempt to inject twelve ounces of sheep's blood into a poor volunteer clergyman two years later was less encouraging. Nothing was known of blood groupings and Pepys later reported that the unfortunate 'guinea-pig' was 'cracked a little in the head'.

Although these experiments were centred upon London and the Royal Society, medical research was equally active elsewhere. It was Leyden not London which by the seventeenth century had inherited the position formerly held by Salerno, Montpellier, and Padua as the outstanding centre of medical education. Its university, founded by William of Orange as a reward for its valiant defence against the Spanish in 1574, was, unlike the post-Reformation Italian universities, open to Protestants, Catholics, and Jews alike. To it flocked students from many lands. The outstanding advances in medical technology were made, however, by Sanctorius of Padua (1561–1636), who designed the first clinical thermometer and a pulse-watch and also invented a weighing-machine in which he sat for much of his life eating, sleeping, and measuring his weight to assess the daily changes occurring in the human body.

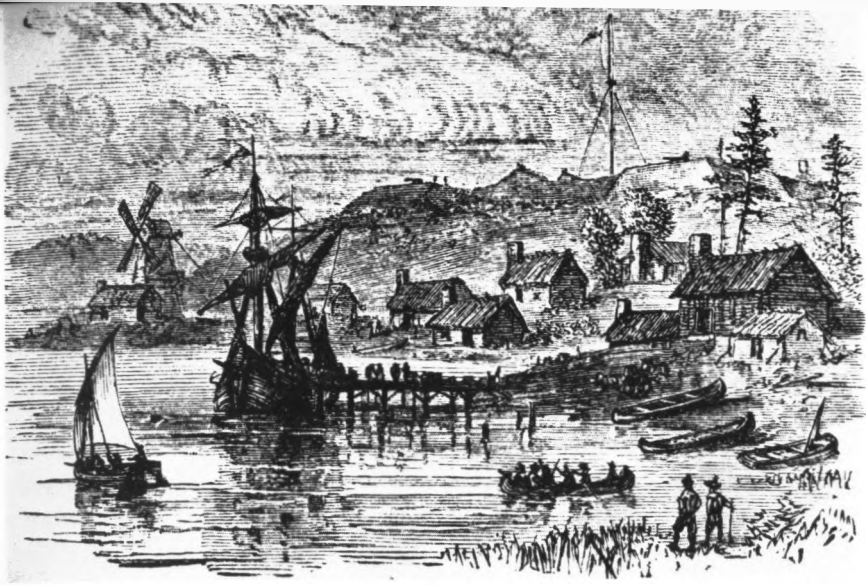
25 A seventeenth-century woodcut showing a blood transfusion from animal to man

Although medicine showed the first signs of becoming the complex, technological profession it is today it would be wrong to assume that the Renaissance era produced any sweeping improvements in medical treatment or public health. During the long voyages of discovery, which were among the greatest Renaissance achievements, dried or salted food and inadequate water-supplies reduced many vessels to floating cemeteries. Columbus in his voyage of 1492 was unusually fortunate in that the health of his ships' companies suffered little. This was because he did not spend long periods at sea and was able to reprovision in the West Indies, rather than because of the presence of a 'surgeon' on each of his five tiny ships. Vasco da Gama's experience upon his far longer voyage of 1497–8 to discover the new sea-route to India was infinitely worse and much more typical. Half his company were lost. Of the 170 men in Magellan's expedition which circumnavigated the world in 1519–21 only fifteen returned to Spain

alive. Many more had died of scurvy, the terrible Vitamin C deficiency disease, than of wounds or drowning. Viking seafarers had prevented scurvy by eating cloudberries and scurvy herbs but this was long forgotten. Until the eighteenth century scurvy's horrors were accepted by sailors as normal hazards of their trade.

Disease presented sea-captains in the 'Age of Reconnaissance' between 1450 and 1650 with baffling problems. In tropical harbours men rapidly succumbed to mosquito-borne diseases like yellow fever and malaria. Although these were not understood it was soon realized that they could be avoided by remaining at sea. If this was done, however, ships' companies faced the dangers of the many diseases encouraged by insanitary conditions on long and overcrowded voyages. Seamen had few facilities for washing their clothes or themselves. Even in big ships the only toilet facilities consisted of open boxes slung over the rail. Sailors, and still more passengers, were reluctant to squat upon such precarious perches particularly in bad weather and therefore eased themselves elsewhere. Filth washed into the bilges gathered among the ballast which consisted usually of sand that acted like a sponge absorbing the semi-liquid sewage. When the stench became unendurable the only solution was to dig out the sand and replace it. Such a herculean task was only accomplished when absolutely necessary and could not be done at sea.

The standards and lot of seamen's contemporaries ashore was no better. In Louis XIV's magnificent seventeenth-century palace at Versailles, which absorbed one-tenth of France's national revenue, the French nobility habitually urinated beneath the stairs and, despite the lavish use of scent, the dirt and smells in the corridors were reminiscent of a city slum. It is therefore not surprising that during the Thirty Years War, which ravaged Central Europe from 1618 to 1648, the total population of the Austrian Empire was reduced from over 16 million to under 6 million. Of these 350,000 were battle casualties. The rest died from famine and disease. The principal pestilence responsible was the acutely infectious typhus fever, also known as camp fever, famine fever, ship fever, and jail fever, spread by body lice and closely associated with war, overcrowding, and starvation. In 1501 typhus was carried from Cyprus to Italy and became widespread with the recurring sixteenth-century famines prevalent in large areas of Austria, Germany, France, and Spain.



26 The first settlement at Jamestown, 1607.
Six of the 208 settlers were medical men

During the seventeenth century the whole of Europe suffered severely and it broke out frequently in Britain and poverty-stricken Ireland. One of its more notable victims was the Swedish 'Lion of the North', King Charles X, whose dazzling military successes were cut short in 1660 when he was only thirty-seven.

The discovery and conquest of America during the sixteenth and seventeenth centuries also had far-reaching medical repercussions. The American Indians had lived for centuries in isolation upon their double continent and had suffered little from the infectious diseases which raged in the Old World. Consequently they had no resistance to them. The Spanish, Portuguese, English, Dutch, and French colonists and soldiers who landed in southern, Central, and North America brought with them all their infectious diseases including measles, diphtheria, meningitis, and smallpox. The last was especially virulent. Beginning in the West Indies where Columbus landed it was carried by Cortés and his *conquistadores* into Mexico where its heavy toll among the Aztecs paved the way for conquest. By 1560 it had spread into South America and was rampant in Portuguese Brazil. In North America too severe epidemics of smallpox and measles swept along the east coast from 1540, and during the seventeenth

century whole tribes of otherwise healthy Indians were decimated, leaving their lands empty for the European invaders. English Puritans thanked God for this unintentional bacteriological warfare, which was far more potent than superior weapons in the rapid conquest of America.

The Indians, however, had their revenge and in exchange sent the scourge of syphilis to Europe. Gonorrhoea was a venereal disease well known to antiquity. Whether the more virulent syphilis existed in Europe before Columbus returned from his first voyage in 1493 is uncertain. If it was not introduced it was certainly reactivated after his sailors landed in Spain and some returned home to Naples. Crucial in its spread was the campaign which the French king, Charles VIII, led against Naples in 1494–5. His 30,000 troops consisted not only of Frenchmen but also German, Swiss, English, Hungarian, Polish, Italian, and Spanish mercenaries. There were also Spanish troops inside the citadel at Naples where syphilis first erupted, causing many deaths. Camp-followers, moving impartially between besiegers and defenders, rapidly infected both armies. When the Neapolitans in desperation drove their harlots from the city, the French obligingly took them in. By the spring of 1495, with his camp ravaged by syphilis, Charles was forced to abandon the siege and his polyglot army dispersed to their various lands carrying the infection with them. The French called it the 'Neapolitan disease'. The Spaniards named it the 'French disease'. Soon it was truly international. Da Gama's expedition carried it to Calicut from whence it accompanied European traders to the Malay peninsula, China, and Japan. Before the end of the fifteenth century Danish armies had carried it to Sweden and it had spread from Poland into Russia where the first severe outbreak occurred at Smolensk in 1499. In Paris one-third of the inhabitants were said to have been infected. The most notable was Charles VIII himself, who died in 1498 aged twenty-eight.

The first great syphilis epidemic of 1493 was of a severity since unequalled. Nevertheless, the settlement of the New World had its compensations in that it gradually brought about the establishment of medical practice there. The first hospital on the American continent was set up by Cortés at Mexico City in 1524; the second by the French in Quebec in 1639; and the third in Montreal in 1644. In

the first English landings by the Virginia Company at Jamestown in 1607, 6 of the 208 settlers were medical men. By 1610, however, disease had almost halved the population and for the next century the English colonies suffered from almost disastrous ill health.

Endemic scurvy, caused by the fear of unfamiliar fruits and vegetables, produced a high death-rate. Return migration and a shortage of female settlers hindered expansion. There was therefore a pressing need for doctors. Only three or four university-trained doctors were resident in Virginia before 1700. To encourage medical immigration the Virginia Company offered free passage to apothecaries and their families. As in England, the apothecary not only made up the prescriptions of doctors and surgeons, but also gave medical advice and sold imported English remedies to the public. These and surgeons, who had either worked in European hospitals or served with the British forces in North America, constituted the majority of medical practitioners. Vast distances, the rapid growth of the country, and the shortage of doctors frequently made self-medication essential. English traditions had already bred the assumption that settlers should attempt all possible cures before resorting to a doctor. Early colonists, therefore, combined in their gardens both 'meate and medicine', growing not only vegetables but the familiar plants and herbs which, with the aid of a herbal, they had used at home. While self-medication remained a necessity, any layman who chose could practise medicine. Only in the next century did there begin to develop the trained, self-reliant, medical practitioner ready to tackle any emergency, for which the wastes of North America became famous.

While medical scientists and their discoveries were ridiculed or ignored general medical practice remained largely medieval. Bleeding was still of paramount importance. Sufferers of all ages were bled for fevers, infectious diseases, and even toothache. One French surgeon bled his long-suffering patient sixty-four times in eight months. Purges and emetics also remained popular for expelling the 'unknown guest' of disease, and physicians extolled the virtues of herbs that 'purged both upwards and downwards' simultaneously. Inducing perspiration and sneezing were also considered beneficial. To help digestion some physicians recommended swallowing grit like the birds, and Sir Hans Sloane, Physician to Queen Anne and a

27 Charles II of England exercising the royal prerogative of touching sufferers of scrofula, 'The King's Evil'

President of the Royal Society, prescribed fifty live millipedes in water twice daily. The Pharmacopoeias, which gave directions for the preparation of medicines, still contained such ingredients as the blood, organs, and excreta of animals and the skulls of executed criminals, which were no different to those recommended in ancient Egyptian

28 An anatomy lecture in 1581 at the Barber-Surgeons' Hall, London. Barber-Surgeons' poles stand by the skeleton

papyri. Belief in faith-healing also continued and the royal custom of 'touching' for scrofula reached its height in England in the reign of Charles II, who 'touched' an average of 4,000 sufferers a year.

Ignorance apart, one of the major handicaps to medical progress in most countries was the intense rivalry between surgeons and physicians. In England both attempted to put their houses in order by the formation of professional organizations. As early as 1518 Thomas Linacre had secured letters patent from Henry VIII to set up a body of physicians to license and examine practitioners and control the activities of apothecaries. In 1551, this organization became the Royal College of Physicians. Thomas Vicary, Chief Surgeon to Henry VIII, also persuaded his master, in 1540, to recognize a union of the guilds of surgeons and barber-surgeons. The Charter of 'The Mystery and Commonalty of the Barbers and

Surgeons of London' stipulated that while surgeons should not be barbers the surgical activities of barbers should be limited to dentistry. Rules were laid down for training of apprentices, fines were specified for unlicensed practitioners and the Company was granted the bodies of two executed criminals a year for the study of anatomy. The utter inadequacy of medicine was again revealed, however, by a further series of plague outbreaks which found doctors no further advanced than they had been in 1348.

There were plague epidemics in Denmark in 1654 and Sweden in 1657. By 1664 it had reached Holland and a year later in an excessively hot summer it broke out in London. Plague was no stranger to the English capital, where close-packed, half-timbered houses harboured the black rat and in the absence of drainage and sanitation householders flung their garbage and sewage into the streets to await the 'rakers', who periodically piled it on the outskirts of the city. The stench was so foul that the rich walked the streets sniffing scented herbs. A visitation in 1563 had carried off a thousand victims a week while it lasted and Queen Elizabeth had erected a gallows at Windsor to hang any Londoner who might come there bringing infection. Some 33,000 citizens had died in the outbreak of 1603 which marred the coronation of James I, and a further 41,000 in 1625. On 7 June 1665 Samuel Pepys ominously entered in his diary:

> This day much against my will, I did in Drury Lane see two or three houses marked with a red cross upon the doors and 'Lord have mercy upon us!' writ there, which was a sad sight to me, being the first of the kind that . . . I ever saw . . .

'The Poore's Plague' of 1665, which began in the slums of St Giles, eclipsed all outbreaks since 1348. By the end of July 2,000 deaths a week were being reported. In August the weekly figure rose to 6,000 and in September to 7,000. Its cause was still unknown. Some blamed the Catholics, or the Dutch with whom England was at war. Others considered it 'God's Judgement' for the excesses of the Restoration Court. Four thousand dogs suspected of spreading infection were destroyed by official slaughterers, leaving the rats free to roam unmolested. The measures ordered by the Lord Mayor were merely a repetition of steps taken in 1603. Official examiners were to report on every house containing suspected cases. Infected dwellings were to be nailed up with their occupants, sick and healthy, inside and

placed under the supervision of watchers day and night. For a fee of 4d 'women of good character' and 'chirurgions' were to examine all corpses to see if they had died of plague. The sick were to be attended by 'nurse keepers', who would be quarantined for a month after the death of a patient. All officials were to carry a red pole as warning that they had been in contact with infection.

These regulations quickly broke down. Pest-houses became overcrowded. There were too many infected dwellings for examiners and watchmen to seal up. Officials themselves could only be found under threat of imprisonment while searchers and nurse keepers were corruptible old women who could be bribed to suppress information. Many victims, including the maid of one of Pepys's acquaintances, escaped from infected houses. Even a nine o'clock curfew to allow the sick 'abroad for ayre' and enable the death-carts to make their gruesome rounds proved useless since the hours of darkness were insufficient for this horrible task. Court and government fled to Oxford. Many doctors followed them or 'went about prescribing to others until . . . they dropped down dead'. By 16 October Pepys reported that 'in Westminster there is never a physician and but one apothecary left'. One of the few who stayed and survived was Dr Nathaniel Hodges, who went about his daily rounds sucking lozenges of myrrh, cinnamon, and angelica root and fortified himself at night by drinking large quantities of sack. Most shops closed. In those that opened customers dropped their money in bowls of vinegar since shopkeepers refused to handle it. Only tobacconists and prostitutes flourished, owing to the popular misconception that tobacco and syphilis afforded protection. Tom Rogers, a King's scholar at Eton, was never so soundly beaten as for failing in 1665 to obey a school rule to smoke. To dispel 'plague venom' in the air huge bonfires were lit in the streets with Newcastle coals worth £4 a chaldron. The dense crowds which gathered served only to spread the infection and proved a fruitful source for pickpockets. At night the streets echoed with the mournful cry of 'Bring out your dead.' Churchyards overflowed and mass burial pits were employed to bury the dead beneath coverings of quicklime. Faced with a future in which 'a man cannot depend upon living two days' some like Pepys went home 'to draw over anew' their wills. Others drank themselves into forgetfulness or went mad. Only as the weather grew cooler in October did

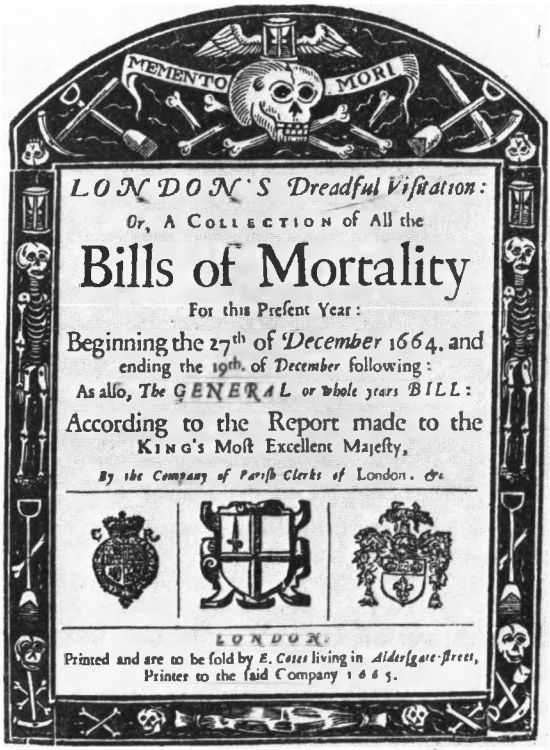
29 Bizarre protective clothing worn by Roman doctors during the 1656 outbreak of plague. With the wand they indicated their orders and avoided actual contact with the patient

the death-rate begin to fall and not until the December frosts did those Londoners who had fled begin to return.

The weekly 'Bills of Mortality', published by the city authorities, are misleading because of falsified returns. By the most conservative

estimate the outbreak must have cost 100,000 lives or over a fifth of the total population. In the country the plague dragged on in the following year and Norwich, second city in England, incurred 2,500 deaths. The outbreak of 1665–6 was, however, the last severe English plague epidemic. This was no thanks to English medicine. London was to some extent purified by the Great Fire of 1666 but the root cause for improvement lay in an eighteenth-century invasion of Norwegian brown rats which eschew human homes and company. Although the brown rat is highly undesirable it does not harbour the plague bacillus and did western Europe the service of driving out the plague-bearing black rat.

30 Title-page of one of the Bills of Mortality produced during the Plague of London



5 The eighteenth century

BY THE EIGHTEENTH CENTURY a mass of new medical discoveries awaited arrangement, classification, and teaching in order that they could be applied in daily medical practice. The man largely responsible for this in the first half of the century was the Dutchman, Hermann Boerhaave (1668–1738). He made no great discoveries but was sympathetic to new ideas and once convinced of their value prepared to use them in his enormous private practice. This son of a country pastor was the greatest clinical teacher of the eighteenth century and one of the greatest of all time. When he became Professor of Botany and Medicine at Leyden in 1701 he introduced the methods of medical instruction practised in modern medical schools. Lectures were not confined to the classroom and laboratory but the signs of disease were demonstrated at the bedside. If a patient died, he made a post-mortem and showed his students the internal disease processes that had given rise to symptoms in life. With only twelve beds available he made excellent use of his limited resources and students from all over Europe and even from America came to Leyden. Inspired by his teachings they returned home to found medical schools in Austria, Switzerland, France, Germany, England, Scotland, and America. Boerhaave's tremendous influence on medical progress can only be assessed in the light of the work of his many distinguished pupils. The Swiss Albrecht von Haller (1708–77) became the founder of modern physiology, collecting and organizing all earlier work in this field to which he added many of his own findings upon respiration, bone growth, the irritability of muscles, and the sensitivity of nerves. Gerhard von Swieten (1700–72), Boerhaave's fellow Dutchman, reorganized the famous Medical School of Vienna. When the Edinburgh medical school was first founded in 1726 many of its earliest professors were also former students of Boerhaave.

Early in the eighteenth century, however, Edinburgh displaced Leyden as the leading centre of medical learning. The Edinburgh

31 The Dutch physician, Hermann Boerhaave, the greatest clinical teacher of the eighteenth century

32 William Hunter, who helped to establish obstetrics on a scientific basis

School of Surgery had originated in 1505. The Royal College of Physicians, later Edinburgh University, had been founded in 1681 by Sir Robert Sibbald. The ambition to make Edinburgh a world centre of medical learning was strongest, however, in John Monro, another former Leyden student, who had been a surgeon in William of Orange's army. To this end he provided an extensive medical education for his son, Alexander, who studied first at Edinburgh, then at Leyden under Boerhaave, and finally under William Cheselden, the famous English surgeon at St Thomas's Hospital. As a result of this grooming Alexander became Professor of Anatomy at Edinburgh in 1720 at the age of twenty-two. In 1758 he was succeeded by his son, Alexander Secundus, and by his grandson, Alexander Tertius in 1798. This remarkable 'dynasty' taught anatomy at Edinburgh for an uninterrupted period of 126 years. During the first seventy years they taught some 12,800 students. Long before their reign ended a Chair of Midwifery had been established and when the Edinburgh

Infirmary was opened in 1741 the Edinburgh medical school had become firmly established.

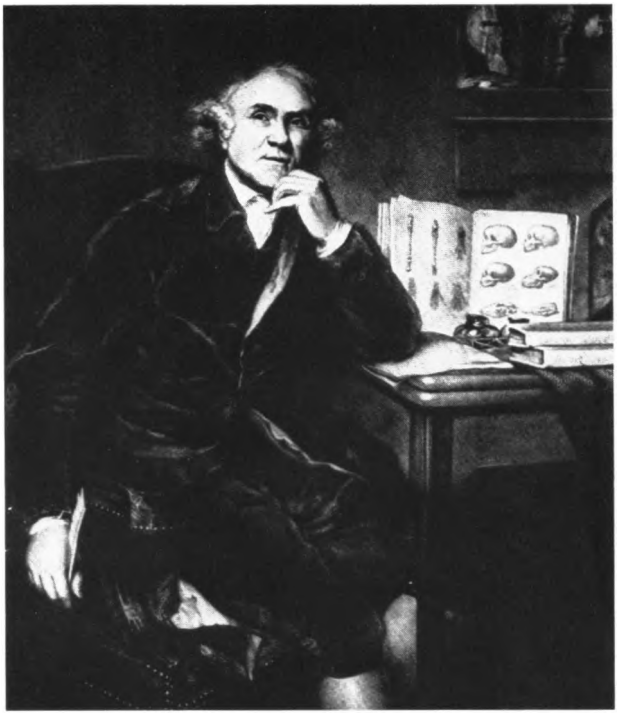
Edinburgh was not the only famous Scottish eighteenth-century medical school. William Cullen (1710–90), a pupil of Monro Primus, who in the second half of the century succeeded Boerhaave as the outstanding teacher of clinical medicine, founded the Glasgow School of Medicine, where he lectured upon medicine and chemistry until he transferred to Edinburgh in 1755. Cullen's outstanding pupil, who practised with him for a short time in Scotland, was William Hunter (1718–83), who came to London in 1742 where he helped to establish obstetrics upon a scientific basis. Midwifery for centuries had been the province of untrained old women, initiated in their art by their forebears, who arrived at confinements carrying the stool which was a symbol of their trade. Another Scot, William Smellie (1697–1763), who had settled in London before Hunter arrived, had already become a leading obstetrician. In ten years 900 students attended his classes and with him attended 1,150 labour cases. Smellie was one of the first to employ forceps. So prejudiced were patients and midwives against them that he used noiseless wooden forceps without their knowledge. Hunter seldom used forceps but none the less became an outstanding obstetrician and as a result of his work 'men midwives' came to stay. He also established an anatomy school at Great Windmill Street where 'he worked till he dropped and even lectured when he was dying'. His famous collection of anatomical specimens became part of Glasgow University's Hunterian Museum. His pupils included the leading anatomists and surgeons of the period, and in particular his more distinguished brother John (1728–93).

The youngest of the Hunter family of eleven children, John travelled to London in 1748. He was destined to become the greatest figure in eighteenth-century surgery. He was not only taught by his brother but also studied with the great London surgeons William Cheselden and Percival Pott. Threatened by tuberculosis, he spent four years as an army surgeon in the warmer climates of Belle Isle and Portugal. Upon his return he devoted the rest of his life to wide-ranging researches in anatomy and physiology. A house in Leicester Square contained his consulting-rooms, lecture-rooms, and museum. The last, built up out of his profitable surgical practice, contained 13,600

specimens of human anatomy and the comparative anatomy of animals, birds, and insects.

Before Hunter's day the surgeon's work was based largely upon anatomy and he had little knowledge of pathology, the study of the morbid conditions present in disease. The Italian, Giovanni Morgagni (1682–1771) had already founded the study of pathological anatomy by correlating post-mortem findings with clinical symptoms. Morgagni was most interested in showing the value of this knowledge to the physician in finding and treating the causes of disease. Hunter taught the importance of it to surgery after experiment had proved the accuracy of his conclusions. He thus raised surgery from a craft to an experimental science. The social status of the surgeon was correspondingly elevated to that of gentleman.

Eighteenth-century medical progress was not limited to medicine, surgery, and obstetrics. There was also something of a return to the Roman concern for hygiene, and a beginning of modern preventive medicine. In 1700 Bernardino Ramazzini, a Paduan professor, published the first book on occupational and industrial diseases. He described the respiratory illnesses of miners and stonemasons which were created by dust, the eye diseases of blacksmiths, and the lead-poisoning of potters and printers. Industrial diseases were to become a more pressing problem with the onset of the industrial revolution a century later. Even before this occurred Ramazzini had drawn attention to the problem and encouraged men to think of ways of prevention. A Viennese professor, Johann Frank (1754–1821), also waged an eighteenth-century campaign to persuade rulers to care for their subjects' health by the provision of efficient sanitation and water supply. Frank's radical belief that governments should be responsible for public health was ahead of its time. Only in the armed forces and prisons could hygiene and living conditions be controlled. Yet here, the authorities were unconcerned and the impetus had to come from humane and interested individuals. Sir John Pringle (1707–82), a former student of Boerhaave who, after training at Leyden and Edinburgh, became a physician to the British Army, was among the first to suspect that dirt might cause disease. To combat typhus, so common among armies, he tried to create in military hospitals effective hygiene, drainage, and sanitation and also experimented with 'antiseptics' – a word which he first coined.



33 John Hunter, brother of William, the greatest of eighteenth-century surgeons

His *Observations on the Diseases of the Army* proposing better ventilation of barracks among other recommendations for soldiers' health sold thousands of copies and was translated into French, German, and Italian.

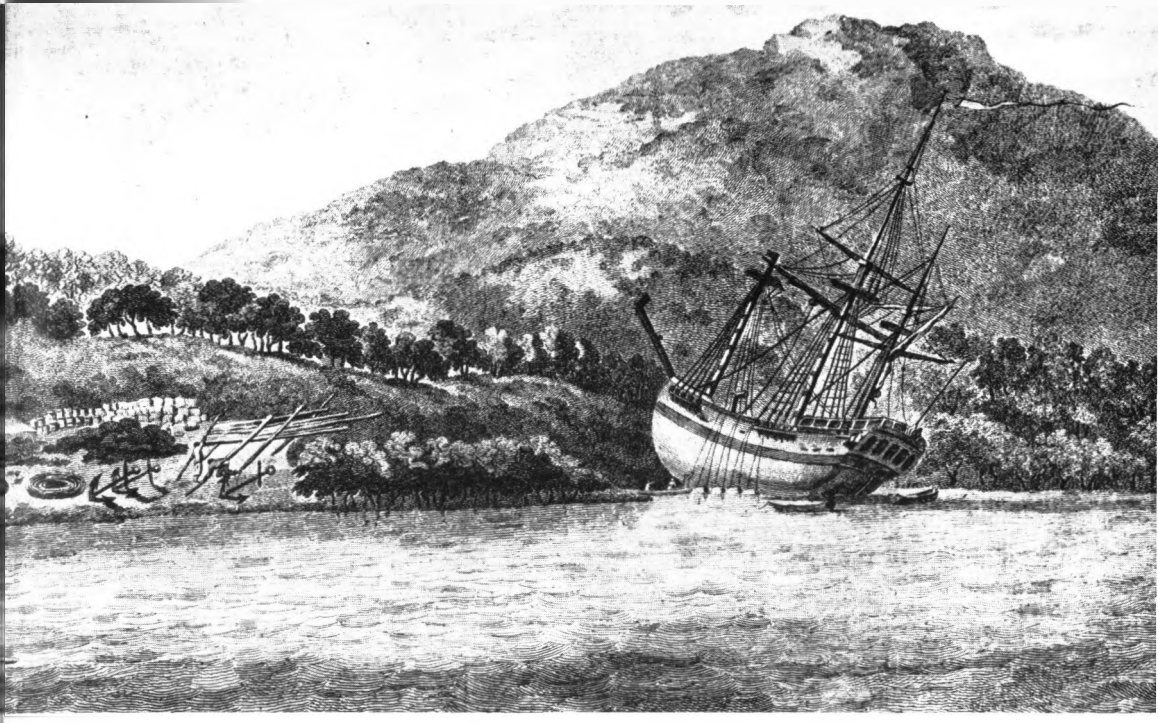
Pringle's naval counterpart was a fellow Scot, James Lind, who was also educated at Edinburgh before serving in the tropical seas. The conditions he found afloat were highly detrimental to health. Cabins were dirty, cold, and damp while a monotonous diet of 'putrid beef, rancid pork, mouldy biscuit, and bad water' meant that at least a third of the crew on a long voyage would die of scurvy. Earlier physicians had advised scurvy sufferers to eat fresh fruit but Lind in his *Treatise on Scurvy*, written in 1753, was the first to emphasize the value of fresh lemon juice and other fresh fruits and vegetables in not only treating but also preventing it.

The scourge of scurvy was re-emphasized when Lord Anson lost 75 per cent of his entire company during his celebrated voyage round the world in 1740–44. In contrast to this dismal record the voyages of the explorer Captain Cook, who with his surgeons followed Lind's

advice assiduously, were a miraculous success. During his first voyage of exploration in the South Pacific in 1768–71, Cook constantly had living quarters scrubbed and disinfected with a mixture of gunpowder and vinegar. Bedding was aired and dried. His stores contained all manner of preparations against scurvy including blocks of 'portable soup', an early attempt at dehydrated food, hops, malt, and large quantities of sauerkraut. When two seamen refused to eat their ration of fresh meat from the pigs and sheep carried aboard, Cook had them flogged. When the conservative sailors jibbed at their sauerkraut he had it served daily to the officers and it soon became so popular that rationing was necessary. The *Endeavour* sailed over 30,000 miles and was absent for two years. True to form the return from Java, 'the land that kills', was like a funeral. At one time only twelve seamen were fit for duty. When the vessel finally anchored off the Kent coast forty-three were dead but they had died from malaria, dysentery, and the East Indies fevers and not from scurvy.

Many in authority believed this was purely fortuitous but on Cook's next voyage of 1772–5, which took him to the Antarctic, the miracle was repeated. On board the *Resolution*, he dosed scurvy sufferers repeatedly with 'robs' (jelly) of lemons and oranges, malt, and other anti-scorbutics such as 'wild celery', and 'spruce beer'. When he docked three and a half years later, only one of the crew of 118 had died, and this was from consumption. He had proved that a ship could remain at sea for three years and still return with a healthy crew. He was awarded the Copley Gold Medal by the Royal Society for his services to humanity but the real credit was Lind's. Two years after Lind's death in 1794 the Board of Admiralty officially ordered lemon juice, fresh fruit, and vegetables to be used in all ships at sea. Not until the twentieth century was scurvy found to be due to Vitamin C deficiency, but long before then it had vanished as if by magic.

Attempts to combat typhus in prisons were less successful. Jails were filthy overcrowded dens of pestilence in which mortality was high. Judges passing sentence did so from behind large bunches of fragrant flowers, believing that fevers arose from the 'miasma' of the prisoners. John Howard (1726–90), the prison reformer, recognized the association between typhus and dirt. At great personal risk and against the opposition of the authorities, he conducted a tour of jails



34 The *Endeavour* – fitted out and maintained under Captain Cook's strict supervision to avoid disease and, especially, scurvy

of England and Wales. Here he advocated medical care for prisoners, segregation of the sick, the introduction of baths, soap, and water, and the fumigation of clothes. His campaign produced results but the lessons he taught were quickly forgotten and in the early nineteenth century James Neild and Elizabeth Fry had to fight the same battles again.

The greatest eighteenth-century breakthrough in the field of preventive medicine was undoubtedly, however, the discovery of vaccination against smallpox. From earliest times smallpox had been a major cause of mortality. Those who survived were left scarred or blind. In the eighteenth century it was particularly prevalent. The innumerable payments to those 'down of ye smallpox' in the accounts of parish overseers of the poor are, however, a reminder that it was largely the poor who lived beneath its shadow. In China from the eleventh century some immunity had been secured by sniffing the

35 Edward Jenner vaccinating his own son against smallpox. His discovery was the greatest eighteenth-century breakthrough in preventive medicine

powdered and dried crust of smallpox pustules. This produced a mild form of the disease and safeguarded the patient against further infection. Not until 1718 did Lady Mary Wortley Montagu, remarkable wife of the British Ambassador to Turkey, introduce the Eastern practice of inoculation into England. An incision was made in the arm and a thread soaked in fluid from a pustule was drawn through it. After this method had been successfully tried upon six condemned criminals, several members of the Royal Family were inoculated and it became widely practised. Doctors quickly mastered the technique and established 'inoculation houses'. One of the most successful was the Quaker physician, Thomas Dimsdale, whose fame became so widespread that the Russian empress, Catherine the Great, summoned him to inoculate her son and herself. The journey was long and dangerous and Dimsdale had to plan his escape lest anything went wrong. Fortunately, all went well. He was rewarded with £10,000, a pension of £500, and made a baron. While in Russia he also inoculated a further 200 people in St Petersburg and Moscow and returned with a fortune. Such was not always the case. Inoculation was sometimes fatal and often left scars. It protected rich individuals

who could afford it but it neither checked smallpox nor its heavy toll.

Of all John Hunter's pupils the one to achieve the most lasting fame was Edward Jenner (1749–1823), a Gloucestershire country doctor whose discoveries made him one of mankind's greatest benefactors. While still an apprentice Jenner had been impressed by the chance remark of a dairymaid that she could never have smallpox as she had had cowpox. Cowpox was a mild disease transferred from the udder of a cow to the hands of its milker which produced a pustular eruption like smallpox. The immunity provided by cowpox had long been common knowledge in Gloucestershire. For over twenty years Jenner in his rural practice at Berkeley pondered upon the relationship between the two diseases. Finally in May 1796 he attempted his crucial experiment. An eight-year-old boy, James Phipps, was 'vaccinated' with pus from the hand of Sarah Nelmes, a dairymaid suffering from cowpox. Two months later Jenner inoculated the boy with smallpox and the disease did not appear. Benjamin Jesty, a Dorset farmer, unknown to Jenner had already tried the same experiment upon his wife and children twenty-two years before, but his efforts had been ignored. At first it seemed as if this might be Jenner's fate too. The Royal Society rejected his evidence and he was obliged to publish it at his own expense. Only support from abroad brought acceptance of his methods in his own country, where, had he chosen to keep vaccination a secret, he could have amassed a large fortune. Even a deputation of American Indians visited Britain to thank him and eventually in 1802 the government voted him £10,000 and a further £20,000 five years later.

Before long thousands of people had been vaccinated. An early method was to take a cow infected with cowpox from village to village for the inhabitants to touch. Soon, however, the process became more sophisticated. The first American vaccination was carried out by Dr Waterhouse upon his five-year-old son in 1800 as the practice spread rapidly throughout the world. Meanwhile, Jenner refused the lucrative prospects of a London practice, choosing to remain in his country birth-place. Here in an arbour in his garden he vaccinated the poor, who as a result of his discovery could now be given protection against one of the most lethal diseases. Vaccination, so called from the Latin *vacca* (a cow), was made compulsory in England in 1853. Throughout the nineteenth century the incidence and mortality

of smallpox fell steadily, its victims coming largely from the unvaccinated. Equally important was the principle established which in the future was to lead to the immunization of men against typhoid, cholera, tuberculosis, diphtheria, and other diseases.

While the beginnings of preventive medicine represented a huge step forward in medical knowledge, eighteenth-century doctors were also helped in diagnosis by new medical instruments and methods. Previously they had felt the pulse with the finger and taken the temperature with a hand to the forehead. Sir John Floyer of Lichfield, however, produced in 1707 a portable pulse-watch which enabled them to count the pulse accurately. A thermometer, like the pulse-watch, had been initially designed by Sanctorius. The mercury thermometer, invented by Fahrenheit, was used by his fellow Dutchman Boerhaave and became readily available in England in the 1740s. Hippocrates had been aware that much could be learned by listening to noises within the body. In 1761 Leopold Auenbrugger, a doctor at the military hospital in Vienna, suggested that percussion on the human chest could help to discover the state of the lungs, a technique he had first learned in testing the level of wine in the barrels at his father's inn. Auscultation, the art of listening to the heart and lungs by putting an ear to the patient's chest, had long been known. In 1816 the practice was revolutionized by the Frenchman René Laennec of the Necker Hospital in Paris. Confronted with a stout patient whose heartbeats were difficult to hear he acted as follows:

> . . . Taking a sheaf of paper I rolled it into a very tight roll, one end of which I placed over the praecordial region, whilst I put my ear to the other. I was both surprised and gratified at being able to hear the beating of the heart with much greater clearness . . . than I had ever done before. . . .

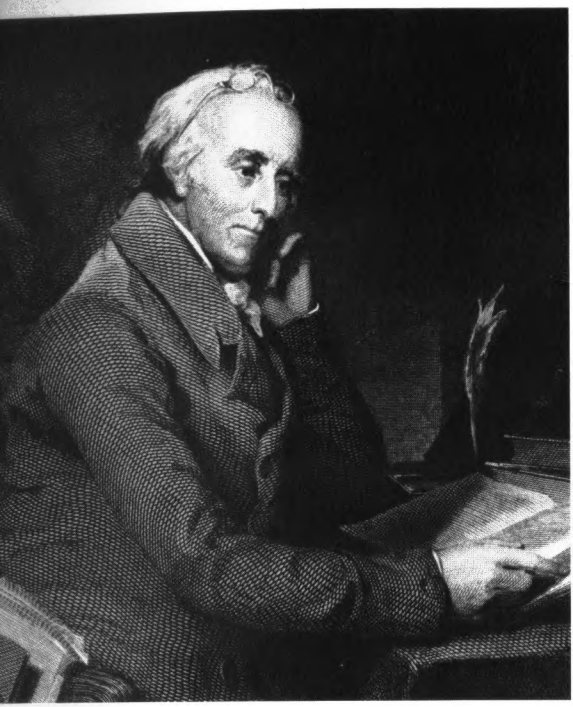
Laennec had invented the stethoscope. He next devised a wooden one that fitted the doctor's ear. Nineteenth-century physicians carried this in their top hats. From it evolved the modern two-eared stethoscope which can be fitted with electronic amplifying devices.

Although most discoveries were western European, eighteenth-century medical achievement was not limited to Europe. Across the Atlantic the period was notable for the formation of an American medical profession. Until a medical department opened at the College

36 John Morgan, founder of the medical school at the College of Philadelphia, 1765

of Philadelphia in 1765 America possessed no medical school. American practitioners who wished to secure the status and fees of the M.D.s who had emigrated from Britain, followed a seven-year apprenticeship with a journey to study medicine at Leyden or Edinburgh. In this way, Boerhaave's teachings crossed the Atlantic so effectively that by 1760 Dr Benjamin Rush, who obtained his medical degree at Edinburgh that year, reported that '. . . The system of Dr. Boerhaave governed the practice of every physician in Philadelphia.' The later colonial period saw also a general improvement in the quality of medical men which accompanied a more urban society and improved living standards as life became more settled. As early as 1736 the Virginia State legislature had fixed fees for medical attention. A surgeon-apothecary was entitled to charge 5s 0d for a visit and prescription within a five-mile radius plus 1s 0d a mile for each additional mile up to ten miles and thereafter an extra 6d a mile. The holder of a medical degree could charge double.

After 1730 a change also took place in the pattern of medical emigration from Britain. The influx of English doctors encouraged



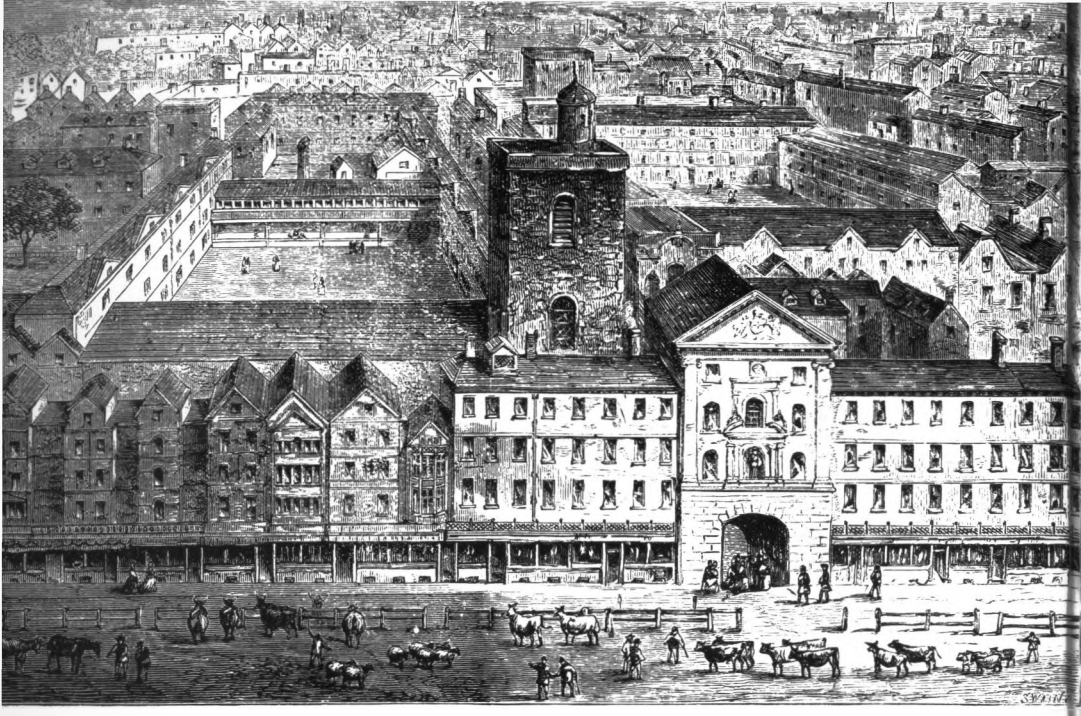
37 Benjamin Rush, a graduate from Edinburgh, helped establish the American medical profession. He was also a signatory to the Declaration of Independence

by personal and national uncertainties decreased while the number of emigrant Scots grew larger. While the towns enjoyed an abundance of trained doctors there was still a shortage in the underpopulated countryside where the medical man like his pioneer neighbour often combined his rural practice with farming. The American War of Independence (1775–83) did much to provide the stimulus which American medicine required. It brought to the forefront a number of American physicians and surgeons who became prominent in the organization of wartime medical services and also in medical education and hospital organization generally. Outstanding among these were Washington's two Surgeons-General, John Morgan (1735–89) and William Shippen (1736–1808). Morgan was an Edinburgh graduate who had founded the Medical School at the College of Philadelphia in 1765. When hostilities began he was appointed to direct the Army Medical Department, only to be unjustly dismissed in 1777 for political reasons. His successor, Shippen, another Edinburgh graduate, also unfairly court-martialled in 1780, was the first teacher of obstetrics in America.

Benjamin Rush, who followed Morgan as Medical Professor at Philadelphia, and John Hunter's pupil, Philip Syng Physick, who held the chair at the same university, were other outstanding American teachers and practitioners of the Revolution era. In general, however, American doctors after Independence still looked to Europe for medical leadership and ideas. Here despite the remarkable advances in medical knowledge there was still little corresponding advance in practice. The fashionable doctor who ministered lucratively to the rich was able to compete in elegance with his wealthy clients. He was distinguished from other dandies only by his gold-headed cane whose hollow, perforated top held an aromatic to preserve him from infection. Prescriptions remained useless, pills became fashionable, and quackery flourished. Impostors like Franz Anton Mesmer claimed to cure by 'the laying on of hands'. 'Piss prophets' promised to diagnose all illness by an inspection of urine. When one impudent charlatan, Joanna Stephens, announced in 1738 that she would disclose her remedy for the stone for £5,000, a subscription was launched headed by two bishops and the Dukes of Richmond, Leeds, and Rutland. When it fell short by £3,000 Parliament supplied the balance out of public funds and Mrs Stephens's eagerly awaited secret was published in the *London Gazette*:

> The medicines are a powder, a decoction, and pills. The Powder consists of Egg-shells and snails, both calcined. The Decoction is made by boiling some herbs (with a base made of Soap, swine's cresses burned to blackness and honey) in water. The pills are Snails calcined, wild carrot seeds, burdock seeds, ashen hays, hips and haws, all burned to blackness, Alicante soap and honey.

Recognition of the curative powers of natural waters was nothing new, as the Roman baths testify. The emergence of a substantial class with adequate leisure and affluence in the eighteenth century produced a boom in European spa going. A change of air and scenery, comfortable living in pleasant surroundings, and desirable social contacts were the principal attractions which drew the wealthy to the pump-rooms of fashionable spa resorts. The complaints for which spa treatment was most commonly and successfully used were skin diseases, rheumatism, gout, and debility. Bathing varied according to the ailment. Cold baths and sudden immersion were used for



38 St Bartholomew's Hospital in 1750. Upon entry to this secular hospital, patients deposited a burial fee which was refunded if they recovered

the feverish while tepid baths were recommended for the debilitated. The benefits of a regular and healthy life in congenial surroundings were often offset, however, by the excesses arising from the social whirl. While the rich ate too heavily and often drank a quart of port a day on doctor's orders, it is no surprise that gout was prevalent and the few who reached a ripe old age were from the ranks of the labouring poor.

The lot of the latter was little more enviable than it had been for centuries. In England, however, a parish doctor was often hired to care for the sick by the Overseers of the Poor. Doctors' bills submitted show clearly that their cures differed little from those practised upon the rich except that in all probability they entailed less care. Some improvement arose from the increased provision of hospitals. After the Dissolution of the Monasteries, infirmaries disappeared and St Bartholomew's, St Thomas's, and the Bethlehem Hospital for the insane, which were re-endowed as secular hospitals, remained the only

three which Britain possessed. In this respect she remained behind most continental countries until the great hospital movement of the eighteenth century. Five of the seven most famous London hospitals – Guy's, Westminster, St George's, London, and Middlesex – were founded between 1720 and 1745 as a result of the charitable activity of such men as Thomas Guy, a bookseller who had made a fortune selling Bibles. The provinces followed. During the course of the century eleven new hospitals were founded in London, thirty-seven in the provinces, and nine in Scotland. In 1769 John Coakley Lettsom, a champion of Jenner and vaccination, inaugurated in London a system of dispensaries which enabled the poor to be treated as out-patients and even be attended in their homes by doctors of quality. This system was again copied throughout much of the country. Hospitals were free, but conditions were such that there was a widespread fear of entry. At St Bartholomew's patients had to deposit 19s 6d as a burial fee, returnable if they recovered. It is small wonder that the upper and middle classes chose to stay at home or went to an inn for operations while people of all classes still practised their own forms of self-medication.

The Reverend James Woodforde, who in 1776 became Rector of Weston Longville in Norfolk, seems to have possessed a copy of Dr William Buchan's *Domestic Medicine or Family Physician* (1769), one of the first home-doctor books, which ran to nineteen editions and was translated into several European languages. He also used a variety of folk-remedies familiar to most people. Woodforde was bled when necessary by the village physician, Dr Thorne. For dental treatment he enlisted the services of an old farrier of dubious vision who 'drew teeth'. For 2s 6d the latter tore away a great piece of the Parson's gum and broke a fang of the tooth with agonizing results. For all other complaints Woodforde applied his own home cures. Bleeding from a mole, cut while shaving, was stemmed by applying a moth in lieu of a plaster. Ear-ache was countered by sleeping with a roasted onion in his ear. A stye on his eyelid was treated less successfully by rubbing with the tail of a black tomcat. For internal complaints, including colic arising from a surfeit of currant tarts and cream, the good clergyman purged and vomited himself relentlessly. His favourite medicament was powdered rhubarb root, regarded by the Romans as a panacea for internal ailments, and imported by

them from China from the first century AD. Malaria, rife in the Norfolk fenlands, was treated by Dr Thorne with quinine and laudanum. Woodforde's treatment was much less orthodox:

> May 22nd, 1779. My boy Jack had another touch of the Ague . . . I gave him a dram of gin and pushed him headlong into one of my ponds and ordered him to bed immediately and he was better after it and had nothing of the cold fit but was very hot. . . .[1]

It is perhaps a matter for surprise that Europe's population began to increase rapidly after 1750. This increase from 140 million in 1750 to 180 million in 1800 was due far more to a decrease in death-rates than an increase in birth-rates. The reasons for this fall were only partly medical. True, bubonic plague had disappeared for good and by the end of the century smallpox had been checked by inoculation and then conquered by vaccination. Better hygiene, more hospitals, and improved midwifery made childbirth less of a gamble with death although it was still an achievement to survive early childhood. Other causes were political and economic. The stronger monarchies of the eighteenth century ended religious and civil conflict and brought increased public order and security. In England an agricultural revolution which increased food production interacted with better and cheaper transport by road and canal to improve food distribution. People were better fed and more resistant to disease. Local famines became fewer. As cheap coal production increased cottages became warmer and dryer and it was easier to fight the winter diseases. The rise of the cotton industry, and an increased supply of soap facilitated the wearing of easily washable cottons instead of less hygienic woollen clothing. The great population rise was to have far-reaching repercussions. In England it provided both a home market and a labour force for the Industrial Revolution. In Germany, France, and Belgium the story was similar. Yet in 1800 doctors still knew nothing of the nature of disease. If smallpox had been beaten in Europe, cholera, typhus, typhoid, and malaria were still undefeated and the victims of tuberculosis 'daily took their leave of us'. When these had been vanquished by the medical and sanitary revolution of the nineteenth century the population of the smallest of the world's continents would double within a century and change the course of human history by spreading throughout the earth.

[1] James Woodforde, *Diaries*

6 The medical and surgical revolution

NOT UNTIL THE NINETEENTH CENTURY was the Greek belief that medicine should be scientifically based fully revived. Once this was accepted medical progress developed at an unbelievable rate, accelerated by scientific achievements in physics and chemistry. While the rapid changeover to an industrial society produced grave problems for doctors to solve, since large towns and improved transport enabled disease to travel more swiftly, industrialization also brought new and superior technical and mechanical devices to use in the fight against disease.

The founder of modern medicine was the Frenchman, Louis Pasteur, who, although not a doctor but a scientist, became one of the outstanding figures of medical history. Pasteur, born at Dole in 1822, was made Professor of Chemistry at Lille University in 1855. Lille was situated in the wine-growing district where the wine makers and brewers were anxious to find why their products so often turned sour. With the aid of a microscope Pasteur discovered that putrefaction was caused by micro-organisms which could be destroyed by heating and sealing, the process of 'pasteurization' upon which the modern canning and bottling industries are based. Unlike Pasteur, scientists had always believed that the bacteria they saw in decaying matter were created by the decay itself. Pasteur proved conclusively that it was the reverse. He then went on to show that these germs were present in the air. His studies of fermentation convinced him that just as one type of microbe produced a certain type of fermentation so a particular type of microbe could also produce a certain disease.

At first he was ridiculed but, despite a cerebral haemorrhage, he began to study anthrax among sheep and cattle which had reached epidemic proportions in France and the poultry disease of chicken cholera. In each case he isolated the germs responsible and grew them in cultures which enabled him to reproduce disease in laboratory animals by inoculation, thus proving his germ theory of disease. His

experiments with chicken cholera led in 1880 to his greatest discovery of all. Returning from holiday he inoculated some poultry with old cultures that he had prepared before he left. The chickens fell ill but recovered. The virus had obviously grown weak so Pasteur made fresh cultures and re-inoculated the same birds together with some others. While the latter died those inoculated with the old and new cultures were unaffected. Repeated experiment showed there was no mistake. Pasteur had immunized the chickens in the same way that Jenner had produced protection against smallpox. A drop of weakened cholera culture would protect chickens from chicken cholera; a drop of weakened anthrax culture would preserve animals from anthrax. Between 1880 and 1885 Pasteur silenced his critics with repeated demonstrations of his vaccines. In 1882 he began to study hydrophobia, transmitted by the bites of rabid dogs, a common and frequently fatal complaint. By 1885 he had made a vaccine which prevented the development of rabies in laboratory animals but which he had not dared try upon human beings. His moment of decision came on 6 July 1885 when Joseph Meister, an Alsatian boy who had been bitten by a mad dog, was brought to his laboratory:

> . . . The death of this child appearing . . . inevitable, I decided, not without . . . some anxiety . . . to try . . . the method which I had found constantly successful with dogs. . . . On July 6th at 8 o'clock in the evening . . . young Meister was inoculated with half a syringeful of the spinal cord of a rabbit which had died of rabies. . . . The days following, new inoculations were made . . . on the last days I . . . inoculated Joseph Meister with the most virulent virus of rabies, that namely of the dog. . . .[1]

Anxious and sleepless Pasteur awaited the result but the boy was cured and rabies conquered. A few months later Pasteur also successfully inoculated a shepherd-boy bitten by a mad dog which he had fought to protect his friends. Again the vaccine was successful and with its extended use world mortality from rabies fell to below 1 per cent. Research institutes throughout the world were opened to commemorate and continue Pasteur's work, including the Pasteur Institute at Paris where, until his death in 1895, Pasteur instructed pupils in the science of bacteriology which he had begun.

The great nineteenth-century German bacteriologists were Robert Koch (1843–1910) and Emile von Behring (1854–1917). Koch was the son of a German miner, and through sheer hard work

[1] L. Pasteur, *Recent Essays on Bacteria in Relation to Disease*

39 Louis Pasteur (left) risked his reputation, possibly his life, by experimenting on human subjects with his untried cure for rabies

qualified as a doctor and secured a country practice near Breslau. A second-hand microscope given him for a birthday-present completely changed his career. He devoted his spare time to the study of microbes and eventually became head of the Berlin University School of Bacteriology, where he developed the techniques of growing and photographing cultures of bacteria still used today. In 1882 he discovered tuberculosis microbes, tiny rod-like creatures which he made visible by dipping tubercular material into blue dye. Two years later he isolated the cholera microbe which had wrought world-wide havoc in the nineteenth century.

Behring, a Prussian army surgeon, who later spent some years at Koch's institute, discovered the principle of serum treatment. In 1890 he found that the blood of an animal infected with diphtheria produced an anti-toxin which tried to neutralize the poisonous toxins of the microbes. If it succeeded the animal recovered. If it failed the animal died. Taking a blood sample from an animal that had recovered he allowed it to stand until the transparent liquid called 'serum' rose to the top. He then injected the serum into guinea-pigs which he tried to infect with diphtheria. The diphtheria would not take since they

40 Robert Koch, the great German bacteriologist who isolated both the cholera and tuberculosis bacilli

were protected by the serum. Like Pasteur, he did not know if the serum would protect people as well until Christmas Night 1891 when a syringeful was injected into a dying child in a Berlin hospital. The child recovered and although its effects lasted only three weeks serum treatment produced a spectacular fall in the diphtheria death-rate.

Pasteur, Koch, and their successors marked the paths to be followed by all modern researchers in their struggle against disease. Soon countless doctors and scientists were working on the same lines until the picture of diseases, their nature, and treatment became more and more complete. First, the organism responsible was isolated; it was then established how it attacked the body and attempts were made to produce a vaccine against it. By the early twentieth century the causes of many killer diseases had been established. The Norwegian Armauer Hansen discovered the leprosy microbe in 1873. The plague bacillus was discovered almost simultaneously in 1894 by the French bacteriologist Yersin, at Hong Kong, and Kitasato, who after working with Koch and Von Behring, became founder and Director of the Japanese Institute for Infectious Diseases. Four years later Paul

Simond suggested that the bacillus was carried to man by the fleas of rats, a theory finally substantiated in 1914. Impetus for further research into bubonic plague came with the last plague pandemic, which fortunately was less virulent than previous outbreaks. Beginning in China in 1893 it passed via India and Turkey to the Southern Hemisphere and South Africa and then on to North and South America. The typhoid and paratyphoid microbes were isolated in 1880 and 1885 and that for bacillary dysentery in 1898. The tetanus germ, cause of deadly 'lock-jaw', was also discovered in 1889 by Kitasato.

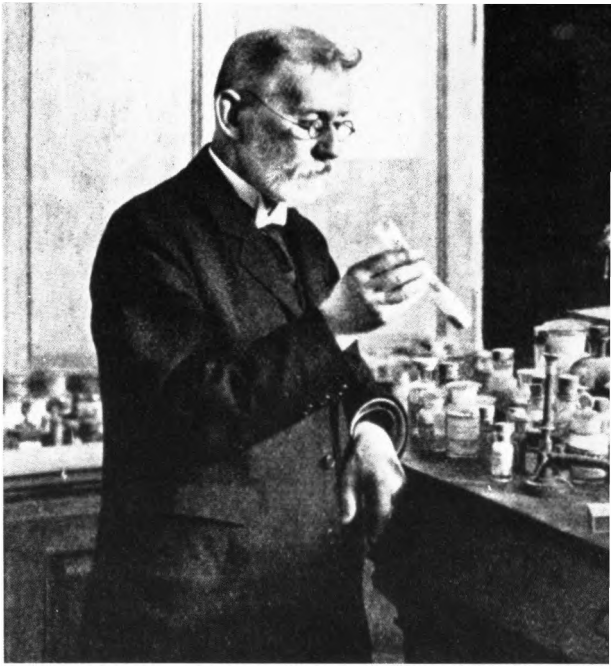
Having established the causes of disease the next step was to find a cure. Vaccines were not always suitable since it was found that all microbes did not produce toxin from which anti-toxin serum could be made. Additionally, serums only gave temporary protection. Pasteur had known that his vaccines worked but not why. By 1900, however, it was known that the body produces antibodies to counter an attack of disease which remain in the body to ward off the disease on future occasions. This was the explanation of Pasteur's discovery but the administration of vaccines of live microbes to provide immunization had first to secure public confidence. The discovery by the American, Theobald Smith, that it was possible to produce antibodies and immunization by injecting microbes killed by heat paved the way for safe vaccines against cholera and typhoid. By 1914 a suitable vaccine had been developed against plague, although not until 1926 was a safe diphtheria vaccine produced. During the Boer War (1899–1902) twice as many British soldiers died from typhoid as at the hands of the enemy. As a result, Sir Almroth Wright of the Army Medical College introduced inoculation against it. His successor, Sir William Boog Leishman, continued the practice so successfully that there was no serious epidemic in the British Army in the First World War. In 1906 Calmette and Guerin, two French bacteriologists, also produced a vaccine against tuberculosis known as 'B.C.G.', now used on a world-wide scale.

As the discovery of effective vaccines forged ahead Paul Ehrlich, a German medical scientist and pupil of Koch, launched the new science of 'chemotheraphy' by beginning the search for chemical substances for the treatment of disease. The main problem was to find a drug which would destroy germs without ill effect to the patient. In 1909,

Ehrlich, after experiments with a vast number of substances discovered '606', or salvarsan, the 606th compound he had tried to find an effective treatment for syphilis. Three years later he introduced the less toxic and more easily administered neo-salvarsan. These were the first of many similar 'magic bullets' to be developed later in the century.

No less important than the discovery of cures for bacterial diseases was the study of the means by which they spread. With the great imperial expansion of European powers in the second half of the century attention switched to tropical diseases. The three principal tropical diseases were sleeping sickness, yellow fever, and malaria. The last, although now vanished from the temperate countries, was still common in the mid-nineteenth century in the marshes of East Anglia, Essex, and Kent. Sir Patrick Manson, who spent twenty-four years in China as a medical officer, was the first to point towards the mosquito as a common link in the transmission of tropical disease. In 1877 he found that the embryos of the minute worms, or filaria, causing the disease were transplanted at night from the blood of one person to another by bites of the Culex mosquito. His paper containing this information, published in 1879, was met with disbelief in the medical world but the theory that blood-sucking insects might transmit tropical disease opened up further inquiries.

In 1880 Alfonse Laveran, a French Army medical officer in Algeria, found the parasite which caused malaria by feeding upon the red blood corpuscles of its victim. In 1894 Manson showed the parasite to Ronald Ross, a young Indian Army doctor on leave, and encouraged him to examine the different species of mosquito to see if any were carriers of the malarial parasite. Next year Ross began his painstaking task. Mosquitoes were caught by hand then allowed to bite a person suffering from malaria. After a while they were killed and examined to see if they had caught the disease. After two years Ross had found nothing. Working eight hours a day in addition to his normal duties his eyesight began to suffer and he neared despair. Finally in August 1897 he tried a female of the Anopheles mosquito. A batch were allowed to bite a malarial patient on 16 August. In the first insects killed, Ross saw no change. When the seventh mosquito was killed on 20 August, however, he immediately noticed cells in the stomach containing a few granules of black pigment identical to that of malaria.

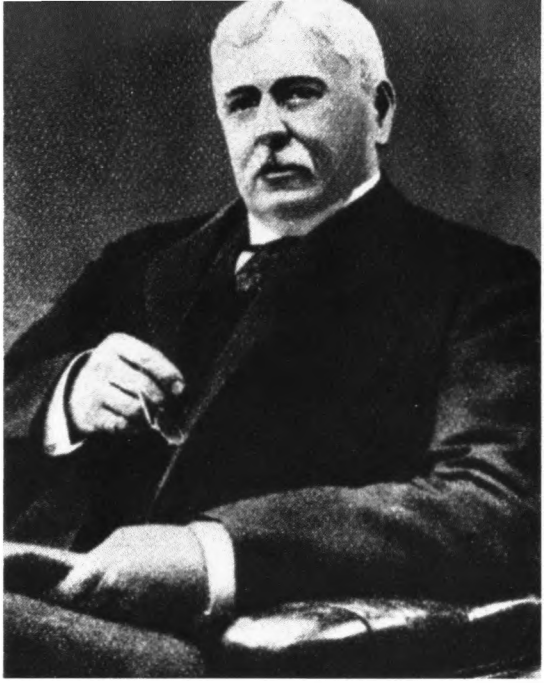


41 Paul Ehrlich, 1854–1915, German medical scientist and Nobel prize-winner

> Next day I went to the hospital intensely excited. The last survivor of the batch . . . Mosquito 39 was still alive . . . I slew and dissected it with a shaking hand. There were the cells again. . . . Just as before only now much larger. Mosquito 38, the seventh of the batch fed on the 16th was killed . . . on the 20th. This one was killed on the 21st, the fifth day after feeding and the cells had grown during the extra day. The cells were therefore parasites . . . and were almost certainly the malaria parasites growing in the mosquito's tissues.[1]

The following year Giovanni Grassi of Rome showed that the Anopheles was the only mosquito capable of transmitting malaria. Although Ross had provided the vital clue, much research was required before the full life cycle of the parasite from mosquito to man and back to another mosquito of the same species was finally established. The first proof was furnished by Manson, who in 1897 had founded the London School of Tropical Medicine. Two of his assistants lived for four months in the Roman Campagna, one of the worst malarial districts in the world, without contracting the disease. Each night they retired to a mosquito-proof hut before the mosquitoes began to bite, thus avoiding infection. Then in 1900 infected mosquitoes were sent from Italy to London and allowed to bite Manson's

[1] Ronald Ross, *Memoirs*



42 Patrick Manson, 1844–1922, pioneer in the field of tropical medicine

son and a laboratory assistant neither of whom had suffered from malaria. When they caught it the evidence was conclusive. Man began to wage war upon the mosquito with insecticides and drainage schemes while also adopting protective measures in the form of mosquito-nets, special boots and clothing, and the screening of dwellings. Quinine, introduced from Peru in the seventeenth century, was still used to combat malaria but during the First World War Germany, afraid that her supplies from the Dutch East Indies would be cut off, produced a substitute, mepacrine. A mepacrine tablet a day kept soldiers free from malaria in the Pacific theatre of operations during the Second World War.

Yellow fever was the second long-standing disease of the tropics. Of American origin, the first definite epidemic was described in Yucatan in 1648. From Central America and the Caribbean, where it was widespread in the seventeenth century, it passed to the southernmost parts of North America and to tropical South America. In 1793 a serious epidemic spread over the northern United States. In Philadelphia alone over 10 per cent of the population died in four months. Aided by dirt and poverty it took hold especially in harbour towns where it became the terror of sailors. Brazil, which had largely

43 Sir Ronald Ross, who discovered that the Anopheles mosquito carried the malaria parasite

escaped its attentions, was infected in 1849 by a brig which docked from New Orleans and within ten years the whole Brazilian coastline was stricken. Nineteenth-century epidemics in the U.S.A. claimed at least 500,000 victims. In Cuba, one of the worst hit areas, over half the summer deaths were regularly attributed to yellow fever, which during the Spanish-American War decimated both armies.

As early as 1881 Dr Carlos Finlay of Havana had expressed the belief that the yellow fever virus was transmitted by the Stegomyia mosquito but had secured little attention. Cuba was captured from Spain by the U.S.A. in 1898 and soon American troops were dying like flies. A commission of army doctors was sent to investigate. It was headed by Walter Reed, a surgeon of the U.S. Army Medical Corps, who had a keen interest in bacteriology. His Second-in-Command, James Carroll, and a third doctor, Jesse Lazear, were also bacteriologists. With Finlay they set to work. Carroll and Lazear allowed themselves to be bitten by infected mosquitoes. The former recovered. The latter died within a few days. Through their courage the connection between yellow 'jack' and mosquitoes was quickly shown. Reed next satisfied himself that the fever was not contagious if mosquitoes were absent. Volunteers slept three weeks in the soiled

bedding of yellow fever victims in a mosquito-proof hut. When none were infected Reed began to sanitate Havana. Victims or suspected victims were isolated from mosquitoes which could transmit the parasite while the mosquito was extensively combated. Within a year Havana was free from the scourge. The chief sanitary officer responsible for initiating Reed's measures was William Crawford Gorgas, who himself had been attacked by yellow fever as a young army surgeon in Texas.

Gorgas, however, is best remembered as the Colonel in charge of the medical department when the U.S.A. took control of construction of the Panama Canal in 1904. Ferdinand de Lesseps, the French engineer of the Suez Canal, had begun work at Panama in 1880. After eight years the project was abandoned since malaria and yellow fever had produced a death-rate of 176 per 1,000. When the Americans renewed the attempt in 1904 Gorgas applied the techniques he had learned in Cuba. Large-scale sanitary brigades were organized and an American Army unit drained the mosquito-ridden swamps of the Canal Zone. The death-rate fell prodigiously and there was no fatal case of yellow fever after 1906. When the forty-mile canal linking Atlantic and Pacific was finished in 1914 the death-rate for the Canal Zone was 6 per 1,000 as compared with 14 per 1,000 in the U.S.A. If yellow fever and malaria had not been conquered this great engineering work would not have been completed.

While yellow 'jack' was the scourge of the Americas, sleeping sickness, which had been present in Africa for many years, reached epidemic proportions by the end of the nineteenth century with the extension of trade-routes and improved facilities for travel. This dreadful disease, which is a chronic fever, leading to death after wasting and somnolence, was first discovered by Winterbottom, an English colonial doctor, who in 1803 described it in Negro slaves imported into Cuba. Not until the early twentieth century, however, did the British Army medical officer, Sir David Bruce, show that the parasite causing it was carried by the tsetse fly and that its spread, like that of malaria and yellow fever, might be limited by the destruction of flies and their breeding-grounds and by restricting the movement of infected people. As a result sleeping sickness gradually ceased to be a major peril in Africa.

Before the outbreak of the First World War a revolution had taken

44 One of the first operations to be carried out using an anaesthetic in Massachusett's General Hospital, U.S.A., in 1846

place in medicine. Much remained to be done but man's knowledge of the causes and cures of major diseases had been vastly extended in a dramatic and fruitful partnership with science which was to produce even more startling discoveries in the future. Medicine was not the only area in which rapid advances were made. From the mid-nineteenth century there was equally spectacular progress in surgery where in 1836 Marjolin, Professor of Surgery at Paris, had sadly commented 'practically nothing more can be achieved'. Diagnosis was more accurate and surgical pathology established but the patient on the operating-table still 'faced danger equal to that of the battlefield'.

Anaesthesia, abandoned at the end of the Middle Ages, was not practised in the seventeenth and eighteenth centuries. Patients were sometimes made dead drunk but nevertheless an operation was surrounded with an aura of horror. Assistants held the patient down as best they could. The surgeon operated as rapidly as he was able and the patient was fortunate if he fainted at the first cut. Only the toughest surgeon could remain unmoved as his patient screamed and fought to

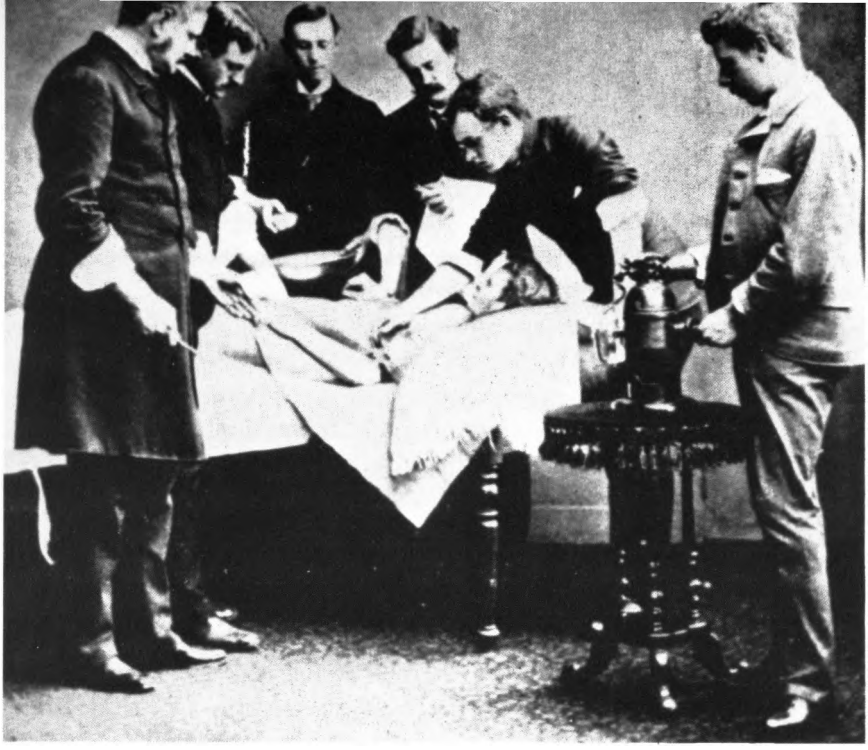
get free. With the exception of a few eminent surgeons in the famous hospitals 'sawbones' were the most despised section of the medical profession. The only way to lessen a patient's suffering lay in speed, although this increased the risk of error. The speed of operations was unbelievable. William Cheselden could 'cut for the stone' in under a minute. Baron Larrey, Surgeon-in-Chief to Napoleon's army, had a best time for an amputation of the arm of seventeen seconds. Some surgeons invited their students to time them and place bets. The surgeon required 'the eye of an eagle, the strength of a giant, and the hand of a lady', combined with a dexterity and agility which few men possessed. The patient needed even more heroic qualities. If he survived the shock and agony of the operation he still had to face the dangers of sepsis whose cause was unknown. Compound fractures which were amputated produced a mortality of at least 25 per cent. Of 13,000 people admitted to the 106 leading British hospitals in 1861 over 57 per cent died, while in 24 London hospitals the death-rate was over 90 per cent. Much septicaemia arose from the habits of surgeons themselves. They operated in old, blood-stained frock-coats with their ligatures threaded through the button-holes or else in their ordinary clothes and shoes. Instruments were unsterilized; hands were not washed before operating; dirty bandages were used for as long as possible, and the surgeons breathed into open wounds. If those perils were surmounted, the danger was not over since medical and surgical cases were packed into the same wards and typhus frequently spread from the former to the latter. Mortality was so high that many surgeons gave up operating. In one St Petersburg hospital only twenty operations were performed in a year. When Sir James Simpson stated that 'a patient was safer in the gutter than in a hospital' his exaggeration was but slight.

As early as 1799 Sir Humphry Davy discovered the anaesthetic effects of nitrous oxide or 'laughing gas' but his suggestion that it might be used in surgical operations was ignored. In 1815 another English scientist, Michael Faraday, noted a similar effect of ether. What Britain discovered and ignored was put to good use in America where Crawford W. Long used ether in eight successful operations between 1843 and 1846, although his achievement was unpublicized until 1849. Horace Wells, a Connecticut dentist, used nitrous oxide at a public demonstration in 1845 at the Massachusetts General

Hospital, but was considered to have failed because the patient, although he felt nothing, groaned throughout. Another dentist, William Morton, however, established anaesthesia on firm ground the following year when he and a surgeon, J. C. Warren, used ether at the same hospital to remove painlessly a tumour from a man's neck. News of the discovery spread rapidly to Europe. On 21 December 1846 Robert Liston, a British surgeon, amputated the leg of a patient in University College Hospital who was under ether. Aided by this 'Yankee dodge' the operation took twenty-eight seconds. In 1847 James Young Simpson, Professor of Midwifery at Edinburgh, after experiments upon himself and two assistants which left them unconscious, found that chloroform was also an anaesthetic and a pleasanter aid to childbirth than ether.

Public opinion was divided upon the use of anaesthetics in childbirth and surgery. Simpson was attacked by both the Scottish clergy and the *Lancet* for 'robbing God of the deep and earnest cries which arise in time of trouble for help'. His greatest ally was Queen Victoria who accepted 'that blessed chloroform' during the birth of Prince Leopold in 1853. It was administered by Dr John Snow, the first British professional anaesthetist, who devised an inhaler designed to give a 4 per cent mixture of chloroform vapour in air. When the Queen's ninth child was due in 1857 and the clamour against chloroform was revived she summoned Snow and angrily told the world 'We are having this baby and we are having chloroform.' The controversy was over and the final seal of acceptance placed on anaesthesia. The hypodermic syringe, invented in 1853, was first used for injecting morphine to produce anaesthesia in 1855. Middlesex Hospital appointed its first anaesthetist in 1874. Cocaine was first used as a local anaesthetic while the patient was still conscious, ten years later. Apparatus for mixing nitrous oxide with oxygen, which improved muscular relaxation, had been produced by 1892, while novacocaine, an improvement upon cocaine, was first used in Germany in 1905.

Anaesthetics had their perils. They themselves could kill or the patient might die later of pneumonia. But pain during operations was abolished and the surgeon could now operate without the frantic haste that resulted in tragedy. Although anaesthetics produced a major leap forward they brought initially a higher death-rate, since



45 A carbolic spray in use before an operation, *c.* 1870

more difficult operations were attempted and patients all too frequently still succumbed to sepsis. Sepsis was still attributed to 'poisonous miasma' in the air but by mid-century many doctors were beginning to doubt this simple explanation. With some diseases the method of the spread of infection and the means of prevention seemed to have been appreciated long before Pasteur showed the existence of bacteria. A notable example was the dreaded puerperal fever, an infection often fatal to women after childbirth. As early as 1773 Charles White of Manchester stressed the need for strict cleanliness and adequate ventilation in the birth-room. In 1843, an American, Oliver Holmes, aroused widespread antagonism when he again suggested that dirty hands in midwifery caused many deaths.

Four years later Ignaz Semmelweiss, a Hungarian doctor at the Maternity Hospital in Vienna, made his great contribution. He noted that of the two obstetric clinics in his hospital the one which had a

high death-rate from puerperal fever was the one visited by students directly after work in the dissecting-room without washing their hands. In the other ward, staffed by midwives who washed their hands before deliveries, the death-rate was much lower. When a friend died after cutting himself during a dissection Semmelweiss was convinced. The fatal symptoms were similar to those of puerperal fever. In May 1847 he posted a notice at the entrance to the clinic ordering all students or doctors coming from the post-mortem room to wash their hands in a basin of chlorinated water. In a few months the death-rate among the mothers had been reduced by 75 per cent and in two years by 90 per cent. Protest against his 'interference' was fierce and eventually he was driven from Vienna to his native Hungary. Nevertheless he was the first to recognize that puerperal fever was a form of blood-poisoning and was the pioneer of antiseptics in midwifery.

In the same year, Joseph Lister, Professor of Surgery at Glasgow, who as a student had witnessed Liston's first 'anaesthetic' operation, made the vital discovery which made surgery safe. Lister was admired and respected as a surgeon but despite his skilful operations many patients died from hospital gangrene. In 1865, reading Pasteur's researches for the first time, he realized that sepsis was caused not by the air itself but by the germs it contained. Pasteur had shown these could be destroyed by heat, filtration, or antiseptics. To Lister the last offered the best protection for a surgical wound. He decided to use the disinfectant carbolic acid which the town of Carlisle had just used to disinfect its sewage. His first experiment was only partly successful since the acid burned the patient's skin. His second experiment upon a Glasgow boy with a compound fracture in which the broken bones had pierced the skin, the type of wound which usually produced gangrene, was much more rewarding.

In subsequent cases Lister applied a solution of carbolic acid to wounds, his hands, his instruments, and to his dressings. To kill germs in the air he devised a spray which pumped carbolic acid into the area where the operations took place, Using these new methods he was able to operate upon parts of the body which surgeons had not previously touched and the wounds healed without sepsis. When he described his first cases in the *Lancet* in 1867 he met severe criticism from British doctors. In 1869 London surgeons condemned

his precautions as 'quite useless'. Doctors entertained their students by slamming the doors of operating-theatres 'to keep Lister's germs out' while students hailed the start of operations with the cry 'Let us spray' as Lister's machine began its work. Part of the difficulty arose because Lister's imitators copied his work badly and death-rates remained high. Surgeons disliked the spray, which made work unpleasant and whose vapours, if inhaled, could be harmful. If his ideas received a lukewarm reception in Britain they were more readily adopted in Germany and America which he visited in 1875 and 1876 respectively. One German surgeon had become so desperate at the infection raging in his hospital that he suspended operations and even considered tearing the building down. When he adopted Lister's methods only 4 out of 139 patients died.

As Lister's ideas gradually secured acceptance in his own land surgeons elsewhere went further and began to establish the principles of asepsis, the complete exclusion of germs from the operating-theatre rather than their destruction after they had arrived there. The first operation performed under sterile conditions took place in 1886 and the following year Ernst von Bergmann, a German follower of Lister, introduced a machine for steam sterilization of instruments and dressings. William Stewart Halstead, a disciple of Lister in America, pioneered the use of rubber surgical gloves, which can be easily sterilized, in 1890. Gauze face-masks were first used in operating-theatres in 1899. In 1912 when Lister, now a peer of the realm, died, almost all operations and operating-theatres had been completely transformed. More than ten times the number of operations were being performed as in 1867 and surgeons were able to operate without fear upon all parts of the body. Abdominal surgery, hitherto un-practised, was much more commonplace, and surgeons were prepared to tackle diseases of the appendix, stomach, intestines, bladder, and kidneys. The first successful operation for appendicitis, previously prevented by risk of infection, was carried out in 1880 and the first open heart wound successfully stitched in Germany in 1896.

As knowledge of physical disease and its cure increased so too problems of mental illness began to gain attention. In medieval and early modern times the mentally ill had been burned as witches or kept in chains. A popular excursion in eighteenth-century London was to view the antics of the inmates of Bedlam, the Bethlehem

Hospital for the insane. The first move towards more humane treatment of the mentally ill came from Philippe Pinel, a Paris doctor, who in 1798 ordered the release from chains of the lunatics in the Bicêtre Hospital. Some of these had been manacled for forty years. His insistence that mental illness should be treated as a disease and not a crime began a new era of scientific and non-restrictive treatment. The new attitude spread to Germany and America and non-restraint was followed by a system of seclusion in which patients were given their own rooms, although these were locked and often padded. There was no improvement in man's knowledge of mental illness, however, until in the latter part of the nineteenth century Sigmund Freud of Vienna began the new science of psychology, a study of the mind and how it worked. Early psychiatrists, who had studied mental illness and its cure, had believed it to result from physical or chemical

46 An outfit designed in March 1909 to protect the wearer during X-ray work

troubles in the body or brain. Freud believed that it was the result of fear of the future or the past. Such fears were often in the unconscious mind, unknown to the patient, and therefore beyond his control. Freud, who died in 1939 in London as a refugee, lived long enough to see his views widely accepted and today they permeate all branches of medical activity.

The great advances in medicine and surgery would have been impossible without the development of a variety of new mechanical aids. Karl Ludwig developed the kymograph upon which respiratory movements and blood pressure could be recorded. In 1851 Herman von Helmholtz, a Königsberg professor, produced the ophthalmoscope which enabled man to see the retina of the eye, while Manuel Garcia's laryngoscope, invented in 1855, enabled doctors to examine the larynx and trachea in the same way that Max Nitze's cytoscope of 1877 permitted inspection of the bladder. The modern-style microscope, introduced in about 1820, was invaluable for diagnosis and research, while in 1867 Dr Clifford Allbutt designed the pocket thermometer, the first practical thermometer for routine use.

Perhaps the greatest technical aid to medicine, however, was the discovery of X-rays. In November 1895 Wilhelm von Röntgen, a German Professor of Physics, while experimenting with cathode-ray tubes discovered that if two metal electrodes were sealed into a glass tube and the air sucked out, and the electrodes connected to a source of electric power, the activated tubes emitted invisible rays which would pass through solid bodies and produce a negative picture of them upon a photographic plate. Uncertain of their nature, Röntgen called them X-rays. Their effect upon medicine was tremendous since they passed more easily through skin and thin layers of muscle than through thick tissues and bone. Thus when plates are developed the former are seen as dark areas and the latter as light ones. For the first time doctors were able to see into the body without operating, which was invaluable for diagnosis. At first X-rays were used only in the diagnosis of fractures and foreign objects but soon it was found that if the patient swallowed or was injected with substances opaque to X-rays, but otherwise harmless, the stomach, brain, bronchial tubes, and kidneys which previously did not show up well were also visible.

Unfortunately, it was not at first realized that X-rays could be

harmful and could burn and damage human tissues. A number of early practitioners met death or mutilation because of inadequate protection against constant exposure. Others contracted cancer of the skin. On the other hand, within a few years X-rays were also being used to treat some skin diseases. The discovery of natural radiation and uranium by the Frenchman Henri Becquerel began a search for elements which emitted rays with similar powers. Marie Sklodowska Curie and her husband, Pierre, began to search the crude ore pitchblende, from which uranium came, to see if it contained a substance with even more ray activity. Since a laboratory was too small for their work they built themselves a hut in the Bohemian mines and began sifting the ore dumps. After removing one known substance after another from a ton of pitchblende they were eventually left in 1898 with a fraction of a grain of the new element they named 'radium'. When Pierre deliberately exposed his arm to radium to test its effect, he obtained a burn which took months to heal but these disastrous powers could be used for good, and with the Curies' discovery the history of radiotherapy in the treatment and destruction of various forms of cancer began. By the eve of the First World War, after less than a century of dramatic progress, the nature of most diseases was no longer a mystery and great steps had been taken towards their cure.

47 Marie Curie, who discovered radium, and so began the history of radiotherapy

7 The transformation of public health

THE GREAT NINETEENTH-CENTURY ADVANCE in medicine and surgery was accompanied by a parallel advance in public health. In 1800 the principal European cities were superficially rich and impressive. Behind the façade of fine houses, public buildings, and squares the majority of their people lived in indescribable squalor. Sewage was left in the streets where is was thrown or tipped into rivers. Much of London drew its drinking-water from the Thames which was no better than a huge open sewer whose stench in hot weather forced Parliament to abandon its debates. In the new industrial towns to which population had flocked to obtain work in the factories conditions were, if anything, worse. Building land was scarce and houses had been crammed everywhere with inadequate air, light, drainage, sanitation, paving, or water-supplies. One means of saving space was to build houses 'back-to-back'. Birmingham had 2,000 such houses by the 1830s while a Scottish doctor described them as 'the curse of Glasgow'. Other cities were notorious for their cellar dwellings which often housed entire families. A doctor reported in 1843:

> Liverpool contains a multitude of inhabited cellars, close and damp, with no drain or any convenience and these pest houses are constantly filled with fever. Some time ago I visited a poor woman in distress. . . . She had been confined only a few days and herself and the infant were lying on straw in a vault through the outer cellar with a clay floor impervious to water. There was no light or ventilation in it and the air was dreadful. I had to walk on bricks . . . to reach her bedside as the floor itself was flooded with stagnant water.

Streets were rarely cleansed; dunghills gathered in the courts and pure water was scarcer than fresh air. Public standpipes ran often for only an hour a day and were turned off at week-ends by water companies who cherished their highly priced commodity. When public pumps existed they were insufficient. A part of St Pancras

had 1 to every 13,000 people. The only alternatives were polluted surface wells. While the older parts of a town might have satisfactory sewers this was rarely so in the newly constructed areas erected for cheapness and in haste. Privies too were a rarity. In 1844 Friedrich Engels found that in one part of Manchester 'for each 120 persons, one usually inaccessible privy is provided'. Two water-closets had been patented before the end of the eighteenth century, Cummings's valve closet of 1775, preceding Bramah's improved water-closet by three years. These were installed only in the houses of the rich and were of doubtful benefit. In London, in the absence of effective drainage, they were one of the factors responsible for polluting the Thames. For the majority the contents of privies were carried away in carts and tipped into cesspools which, when full, were covered over and new ones dug. With the increase in population the disposal problem became steadily worse. In 1839 Leeds Corporation admitted that a privy in its notorious Boot and Shoe Yard had not been cleaned for seven years. When the task was eventually accomplished it realized seventy cartloads of filth.

Elsewhere, sewage was guarded more jealously in empty rooms until it could be sold as manure. It is not surprising that in the British industrial towns of the early nineteenth century the downward movement of the death-rate at the end of the eighteenth century was reversed. A Rutland farm-worker could expect to live twice as long as a factory-worker in Manchester. In Bradford average life expectancy was only twenty years and the Commissioners of 1842 who reported that 'the annual loss from filth and bad ventilation is greater than the loss from death or wounds in any war in which this country has been engaged in modern times' were fully justified in their claim. Since Britain was the first country to undergo the impact of industrialization such problems were highlighted there first. In less industrialized cities elsewhere, however, conditions were little different. In New York in 1832 the only efficient scavengers were thousands of swine which roamed the streets – hence ordinances to control them were never enforced. The decomposing filth which adorned the thoroughfares was affectionately known as 'corporation pie' in tribute to a Common Council which neglected to collect it. New York water was held to be superior to any other since it served as a purgative as well as for washing and cooking. Only the poor, crammed into tiny,

unventilated apartments, used the city pumps. The rich bought their water in hogsheads from the 'pure' wells of the countryside. While such conditions were breeding an increase in tuberculosis, typhus, typhoid, dysentery, and scarlatina an unwelcome but spectacular ally to the poor was on the way.

Cholera was the classic epidemic disease of the nineteenth century as bubonic plague had been in the Middle Ages. Before 1817 it was restricted to the Far East but during the nineteenth century it spread throughout the world. One of the most severe of all diseases, its homeland was in the swamps of Bengal and the Ganges Delta. Outbreaks with symptoms typical of cholera are recorded there in 400 BC but large epidemics only began at the start of the fifteenth century. From the close of the eighteenth century it claimed many victims among pilgrims and English garrisons in India. Not until 1817, however, was the attention of European physicians attracted by a particularly violent epidemic in Bengal which moving westward swept through Central Asia to southern Russia by 1823. Simultaneously it also spread eastwards to Malacca, Siam, and Japan. Three years later a yet larger pandemic moved via Arabia and Persia to Astrakhan. Here it claimed 24,000 victims before crossing Russia to reach Moscow in 1830. By May 1831 Hungary, Poland, Germany, Austria, and Sweden were also infected and the disease had reached the Baltic and North Sea ports.

Britain's trading connection with these ports created much concern. Elsewhere attempts to exclude cholera had failed miserably. Russian troops had surrounded infected villages and shot peasants who tried to leave. Prussian soldiers had been posted along her frontiers but all to no avail. Nevertheless every belated effort was made to keep cholera from the British Isles. Warships patrolled the coasts and forced vessels from infected ports into quarantine stations. In the absence of a central government department for health a temporary Board of Health was established in June 1831 consisting largely of leading doctors whose task was to make regulations to keep cholera out and prevent its spread if it arrived. Two of its members were hastily dispatched to Russia to study the disease. In October it advised the establishment in every town and village of a local Board of Health to make its own preparations, such as earmarking houses as cholera hospitals, recruiting local women as nurses, cleaning the

48 Street scene in a London slum which could be paralleled in most nineteenth-century towns

streets, and whitewashing and fumigating the homes of the poor. Prayer, quarantine, and whitewash were in vain for in October 1831 the first case of cholera was diagnosed in the port of Sunderland where 19,000 people were crowded into insanitary tenements and rubbish and sewage were dumped on the Town Moor.

Two forms of cholera were known to British doctors in 1831. English Cholera, sometimes described as 'autumnal diarrhoea', was common and not generally fatal. Asiatic or Indian Cholera, also known as 'cholera asphyxia', the 'black illness', and the 'blue vomit', was a different matter. It struck with appalling suddenness. The first signs were usually giddiness followed by 'a prodigious evacuation when the whole intestines seemed to be emptied at once'. Body move-

ment was then accompanied by violent vomiting and diarrhoea. The odourless, rice-water motions of the victim became the classic diagnostic sign. The body often lost several pints of fluid in minutes and dehydration made the patient shrivelled. These symptoms were followed by 'cramps', which began with acute pains in the fingers and toes spreading upwards to the chest and stomach. The features became black or blue, breathing was difficult, and violent convulsions contracted the body almost into a ball. A victim who survived the agony of the cramps could still recover but if the attack was severe he passed into the final stage of collapse giving way to coma and death.

Retired British naval, military, and East India Company doctors were familiar with the symptoms. Nevertheless when cholera arrived in Sunderland it was incorrectly diagnosed as English diarrhoea. The first case to be officially recognized was Robert Sproat, a keelman 'near the age of sixty', who after being troubled with diarrhoea for a week collapsed on 22 October seized with 'rigor, cramps, vomiting, and purging'. By 26 October 'he was much weaker . . . countenance quite shrunk, lips dark blue, as well as the skin of the lower extremities. . . . At 12 o'clock he died.' Other fatal cases followed, including Sproat's son and an old woman who had nursed him, but by the time the harsh truth had been reluctantly admitted by the medical and mercantile communities of Sunderland it was too late. Shipping was forbidden to sail. Other major north-eastern towns forbade Sunderland citizens near their boundaries. Armed guards were posted on the roads but by the end of the year cholera was rampant in Newcastle, Gateshead, and the insanitary villages of the Tyne. From Tyneside it spread north and south like wildfire reaching Edinburgh and London almost simultaneously in January 1832. In the crowded, insanitary hovels of the poor without privacy, sanitation, or water, few diseases could have been more ghastly.

Doctors knew little of its causes and nothing of its cure. They were divided into contagionists and miasmatists. The former believed that cholera was spread by physical contact with the persons, clothes, or bedding of the infected. The latter believed it travelled 'on the wings of the air'. As in 1348 popular opinion sided with the miasmatists. In one Persian city salvoes of artillery roared from dawn till dusk in conjunction with gongs and trumpets to drive the cholera away. At Exeter barrels of tar smoked in the streets and at Marseilles huge crowds

49 At Marseilles, bonfires were lit in the square of the old Palais de Justice in an attempt to wipe out cholera. The scene is reminiscent of the Middle Ages

danced round public bonfires. Elsewhere heaps of tobacco smouldered to disinfect the atmosphere while at Cromarty, northern Scotland, strangers were fumigated with sulphur and chloride of lime. The remedies of doctors were equally useless. Some tried cold water and ice to save the system from collapse. Others experimented with hot compresses and baths. One doctor who employed hot air to warm his patient's bed merely set it on fire. A second used the even more novel method of electricity but all his patients died. The majority were more conservative, relying upon bleeding, vomiting, calomel, and opium, horse-radish, black pepper, and ginger – none of which worked. The wearing of a flannel cholera belt round the stomach, which spread from Poland, proved as fruitless as the practice of drinking sea-water in Ireland.

The inability of doctors to find any cure produced a strong reaction against them. In Russia it was claimed that cholera was the result of a conspiracy by foreign doctors. A large crowd stormed the St Petersburg Hospital, manhandled its staff, many of whom were foreigners studying the disease, and 'rescued' the patients. Only the appearance of the Tsar saved a difficult situation. In Britain similar

50 Conditions in the London slums were ripe for the spread of disease as this engraving, entitled *A court for King Cholera*, shows

scenes ensued. The two doctors who first diagnosed cholera in Ireland, already racked by famine, were lucky to escape alive. Their carriage was attacked on the outskirts of Dublin and only with difficulty did they outstrip their pursuers.

As cholera decimated the British Isles in the summer and autumn of 1832, the atmosphere became reminiscent of the dreadful days of the Black Death. Clothes and possessions of the dead were burned or buried in quicklime on the instructions of the Central Board of Health. Cholera victims were interred in separate burial-grounds since it was feared that cholera would be reactivated if their remains were disturbed in the future. Coffins were carried 'underhand' on rope webs instead of on the bearers' shoulders. Because of the resentment of the poor, who frequently rioted against these precautions, many dead were buried at night. By the time the epidemic ended in the spring of 1833 it had touched every corner of the British Isles, killing some 60,000 people including 7,000 in London, 3,000 in Glasgow, and 1,500 in Liverpool. Britain's death-roll was proportion-

ately much lower than in Belgium, Prussia, Poland, Austria, and Russia. 1 in 20 persons died in Russia; 1 in 30 in Austria; 1 in 32 in Poland, and 1 in 131 in Great Britain.

From America the European outbreak had been watched with apprehension. Americans consoled themselves that a land of 'health, virtue, and rustic simplicity' might be spared the terrors which had afflicted urban, industrialized Europe. On 18 May 1832 the *Brutus*, a 400-ton emigrant ship, left Liverpool for Quebec carrying 330 pauper emigrants to the agricultural land of Canada. When cholera broke out aboard the Captain put back. By his return 124 passengers had cholera and 83 were dead. Not all ships emulated the *Brutus* and soon many were leaving in their wake a trail of bodies swathed in sail-cloth and bundles of infected bedding. By 6 June cholera was in Montreal and spread westwards throughout Canada. America had already invoked strict quarantine regulations against the European ports but these were useless against a spread of infection from Canada. Towns in Upper New York State, Vermont, and along the Erie Canal attempted further regulations without success. Unwelcome emigrants from cholera ships, hastily driven southwards from Canada, leaped from canal boats and passed the locks on foot despite efforts to stop them by the militia. By 14 June cholera was in Whitehall, New York, and by 18 June at Mechanicsville and Ogdenburg. Roads leading from Albany, New York, and Philadelphia were already packed with rich families leaving prematurely for country homes when the first cases in New York, an Irish immigrant family named Fitzgerald, were diagnosed at the end of June. The streets, unaccustomedly clean and strewn with lime, were silent. Even on Broadway passers-by were so rare that a rider drew curious faces to the windows. Business stagnated and the poor became destitute.

> Cartloads of coffins rumbled through the streets . . . bodies lay unburied in the gutters. . . . Harsh smoke from burning clothes and bedding filled the air mingling with the acrid fumes of burning tar, pitch, and other time-tested preventives. Homes stood empty, prey to dust, burglary and vandalism. By August many of the churches were closed – especially those with wealthier congregations.[1]

As in Europe the lower classes forcibly discouraged attempts to remove their sick to the five cholera hospitals hurriedly established

[1] Charles E. Rosenberg, *The Cholera Years*

by the New York Board of Health. By 20 July the epidemic had reached its height although it smouldered on throughout the Fall and did not completely vanish until Christmas, leaving an immense mortality. The New York visitation was short-lived but cholera did not halt there. America prided herself upon her railroads, canals, and steamboats. Soon it was travelling upon all three. It reached the military posts of the Upper Mississippi and followed the army of General Scott upon his campaign against Blackhawk, slaughtering Indian and white man indiscriminately. Few communities, however remote, escaped between Maine and Wisconsin. By August it was also wreaking havoc in the plantations of the South despite daily fumigation with burning sugar and vinegar. Cholera hospitals, frenzied clean-ups, and quarantines were instituted everywhere. In Pennsylvania several persons suspected of infection were murdered with the man who sheltered them. Armed Rhode Islanders turned back New Yorkers fleeing across Long Island Sound, while at Ypsilanti local militia fired upon the mail-coach from cholera-stricken Detroit. Despite such efforts only Boston and Charleston of America's major cities escaped. When cholera broke out in Chicago terror-stricken settlers fled, preferring to take their chance with the Indians. At New Orleans, probably the most seriously hit of all American cities, the death-roll reached 5,000. After a period of quiescence during the winter cold cholera again broke out with undiminished violence in the West and South. A case in the smallest frontier farm produced a general exodus spreading the disease throughout the surrounding countryside and leaving the victim to die untended. After a further American outbreak in 1834, it passed on to Mexico and in 1835 was widespread throughout North Africa before the first great epidemic finally disappeared.

The world, however, had not heard the last of 'King Cholera'. After a lapse of only ten years it was back to find few lessons had been learned in its absence. From Kabul it swept into the Middle East. At Teheran a fifth of the inhabitants died. In Baghdad 30,000 deaths left the town deserted. In 1847 it was at Mecca where 2,000 pilgrims succumbed in a single night. It then passed into Russia along the tributaries of the Don to reach Moscow and St Petersburg on the sixteenth anniversary of the outbreak of 1831. Europe, in its 'year of revolution' was simultaneously swept by the contagion of cholera.

In Britain the epidemic of 1848–49 was more severe than before. Half a million cases brought 130,000 deaths. By December 1848 the packet-boat *New York* had again transferred the infection from Le Havre to America. Other vessels with cargoes of unwashed immigrants from Hamburg and Bremen brought it to New Orleans from which it passed to steamboat landings along the Mississippi, Arkansas, and Tennessee. By mid-May over 5,000 New Yorkers were dead. As the 'Forty-Niners' moved westwards to California their route was marked with wooden crosses bearing the terrifying word 'Cholera'. In the insanitary villages of the Indians the epidemic wrought havoc. Convinced that they had been deliberately infected they took terrible revenge upon the covered wagons streaming towards the diggings. Mortality was particularly severe in the infant cities of the West without adequate water-supply or sanitation. St Louis and Cincinnati lost a tenth of their inhabitants while by September 1849 10,000 slaves in the Southern States were dead and the price of Negroes had risen accordingly. In 1850 before a shaken world had recovered the Mediterranean countries were again infected. Poland and Germany followed in 1851, and Russia, Scandinavia, and the rest of Europe during the next three years. A British mortality of 30,000 was again relatively light but 140,000 victims in France showed that cholera had lost none of its sting. Further epidemics erupted on a world-wide scale in 1860–68 and 1870–73. In the former 70,000 died in Zanzibar, 190,000 in Hungary, 90,000 in Japan, and 50,000 in the U.S.A. where the outbreak completed the disastrous years of civil war. In European Russia 130,000 succumbed in a single year while in Latin America cholera spread for the first time from Brazil to the western coast. A final pandemic, originating in India in 1891, lingered in Russia until 1896. It was particularly severe in Hamburg but by this time thanks to improved hygienic measures cholera was losing its hold in western Europe and North America, and by the close of the century it had become a thing of the past.

Cholera, as destructive in the nineteenth century as the Black Death in the Middle Ages served one useful purpose. Although it hit hardest in the slums it could also spread with equal rapidity to the more affluent suburbs. The immediate result of its coming was to awaken a new and widespread interest in public hygiene for which governments were reluctant to assume responsibility. The idea that

the state should care for the well being of its members developed only slowly. In an age of *laissez-faire* no government wished to 'interfere' in the private affairs of men and was opposed to laws which might affect the sacred rights of property. Cholera was but one of the many killer diseases nurtured in the new industrial towns. While its sudden epidemics had the most spectacular impact, tuberculosis 'captain of the armies of death' was more consistently dangerous. Typhoid too took a regular toll as did smallpox among the unvaccinated. Infant and child mortality was tremendously high. Three-quarters of the deaths from infectious diseases were of children under five. Since these diseases were difficult or impossible to cure emphasis had to be placed upon prevention, which meant a campaign for purer water, effective drainage, and slum clearance – a social revolution comparable with the changes wrought by the Industrial Revolution.

In Britain although the temporary Boards of Health, set up to deal with the 1831–33 cholera outbreak, were allowed to lapse afterwards, they provided a future pattern. The 1830s saw a series of public inquiries into health and living conditions promoted by pioneers like the Poor Law reformer, Edwin Chadwick, or energetic doctors like Southwood Smith. In 1842 Chadwick, on behalf of the Poor Law Board, published a *Report on the Sanitary Condition of the Labouring Population of Great Britain.* Perhaps the most important document in the history of public health, it contained information supplied by all the Poor Law physicians in the land on health conditions in their unions and was the first attempt at a comprehensive survey of national health. Its 457 pages were packed with 'sanitary maps' illustrating how diseases like cholera were concentrated in the worst-drained areas of towns, statistical tables showing how life expectancy varied in different places, and many suggestions for improvement. Chadwick believed there should be a unified system of sanitary control with one body responsible for sanitary matters in any town. He calculated that all families could be provided with a decent house in an efficiently drained street with private tap and lavatory for a rent increase of $3\frac{1}{2}d$ per week. This was infinitely less than the cost to the Poor Law of supporting widows and orphans left destitute by the loss of their bread-winner through disease. The report also contained details of one of the most vital, but most forgotten nineteenth-century inven-

51 This *Graphic* illustration shows how cholera was suspected of spreading in Egypt. These mourners are riding home from a funeral in the coffin of the deceased

tions – the round, hollow-bore, glazed, earthenware drain-pipe, which would carry away sewage more efficiently than the old brick tunnels or wooden pipes. This was the key to Chadwick's 'arterial system' whereby every home would be supplied with piped water, the waste from which would carry away household sewage. The report, which sold 10,000 copies, was a sensation. It was read by Queen Victoria, and quoted everywhere. Ultimately it produced a Royal Commission to investigate the state of large towns and populous districts, which revealed that only one of fifty towns had a satisfactory sewage system and only six an adequate water-supply.

A Health of Towns Association formed in 1844 numbered among its keenest members clergy and doctors who had encountered the ravages of cholera at first hand. Many M.P.s, however, were still unwilling for the government to accept responsibility for public health. Only the second approach of cholera overrode the 'dirty party' and produced the first Public Health Act in 1848. This established a national Board of Health of which Chadwick became chief member and Southwood Smith Chief Medical Officer. Towns were encouraged to appoint local boards of health but were only compelled to do so if there was a strong demand among the citizens or if there was a death-rate of over 23 per 1,000.

The national Board of Health enjoyed little success. British traditions of self-government were hostile to central government interference. Chadwick was dictatorial and tactless. His activities aroused widespread opposition. Owners of slum property resented sanitary regulations which would increase their expenses; manufacturers inveighed against efforts to suppress nuisances. Ultimately in July 1854 the first Board of Health was dissolved and Chadwick and Southwood Smith were dismissed with pensions. Its successor survived only until 1858 when responsibility for public health passed to the Privy Council. Chadwick had had insufficient time to clean up England's towns. Nevertheless before his dismissal 200 towns had appointed local health committees. These included London where John Simon, the first Medical Officer of Health, had in a few years abolished cesspools and by 1870 established an efficient sewerage system. Most provincial cities, however, lagged behind and much remained to be done. Again the impetus came from cholera.

In 1849 Dr John Snow, who had a practice in London's Soho, published a book *On the Mode of Communication of Cholera*. In it he suggested for the first time that cholera might be spread by water-supplies polluted with cholera excrement. In the 1854 epidemic the chance came to test his idea when in an area of Soho only 250 yards long there were over 500 deaths. If, reasoned Snow, cholera was caused by atmospheric conditions why did it decimate one street but barely touch the next? Why did the occupants of some houses catch cholera while the occupants of others escaped? The answer, Snow found, was centred round a pump in Broad Street. In virtually every house where its water had been used the disease appeared, whereas not one of seventy men in an adjacent brewery, who drank beer at work, were affected. When Snow persuaded the authorities to remove the pump-handle the epidemic ceased.

Snow also showed that piped water could be equally dangerous if its source was infected. He also explained some of the lesser mysteries of cholera. Sailors and dockers were badly attacked because they often drank polluted river-water. Women and children were more susceptible than men because they were less mobile, and drank more water, particularly the contaminated water of their homes. Cholera was not caught but was swallowed. It spread so quickly among the poor, who rarely washed, because in dark, overcrowded, and insanitary condi-

BOARD OF WORKS
FOR THE LIMEHOUSE DISTRICT.
COMPRISING LIMEHOUSE, RATCLIFF, SHADWELL & WAPPING.

In consequence of the appearance of **CHOLERA** within this District, the Board have appointed the under-mentioned Medical Gentlemen who will give ADVICE, MEDICINE, AND ASSISTANCE, FREE OF ANY CHARGE, AND UPON APPLICATION, AT ANY HOUR OF THE DAY OR NIGHT.

The Inhabitants are earnestly requested not to neglect the first symptoms of the appearance of Disease, (which in its early stage is easy to cure), but to apply, WITHOUT DELAY, to one of the Medical Gentlemen appointed.

The Board have opened an Establishment for the reception of Patients, in a building at Green Bank, near Wapping Church, (formerly used as Wapping Workhouse), where all cases of Cholera and Diarrhœa will be received and placed under the care of a competent Resident Medical Practitioner, and proper Attendants.

THE FOLLOWING ARE THE MEDICAL GENTLEMEN TO BE APPLIED TO:--

Mr. ORTON,
56, White Horse Street.

Dr. NIGHTINGALL,
4, Commercial Terrace, Commercial Road, (near Limehouse Church.)

Mr. SCHROEDER,
53, Three Colt Street, Limehouse.

Mr. HARRIS,
5, York Terrace, Commercial Road, (opposite Stepney Railway Station.)

Mr. CAMBELL,
At Mr. GRAY's, Chemist, Old Road, opposite "The World's End."

Mr. LYNCH,
St. James's Terrace, Back Road, Shadwell.

Mr. HECKFORD,
At the Dispensary, Wapping Workhouse.

By Order,

BOARD OFFICES, White Horse Street, 26th *July*, 1866.

THOS. W. RATCLIFF,
Clerk to the Board.

52 Precautions against cholera issued by the Limehouse Board of Works. Even in this last British cholera epidemic, 7,000 people died in London in a few weeks

tions they touched each other's soiled clothing or bedding before eating. It was not infected air but flies which deposited in food and water the bacilli picked up in cholera-stricken homes that accounted for the strange cases where it appeared to leap-frog across country.

Snow died in 1858 without seeing his theory finally accepted. Conclusive proof, however, was forthcoming in the last British epidemic of 1866 when 7,000 people in London's East End died in a few weeks after an employee of the East London Water Company had allowed water containing cholera-infected sewage into their water-supply. Robert Koch, the German bacteriologist who first successfully isolated the cholera bacillus in 1884 during an outbreak in Egypt,

53 New York, 1871: a smallpox victim is left to die in the snow

reached the same verdict the following year when he concluded that cholera periodically set out on its world march from the water-tanks of the Ganges Delta. Further confirmation, which silenced most doubters, was provided by Koch from the Hamburg outbreak of 1892. Eighteen thousand citizens, who drew their daily water from the Elbe caught cholera and 8,200 died while neighbouring Altona with pure water-supplies remained untouched.

These lessons were not forgotten. In Britain the 1866 Sanitary Act forced local authorities to appoint sanitary inspectors and empowered the government to make them take action about water, sewerage, and nuisances. Five years later responsibility for public health passed to the newly established Local Government Board, the President of which was usually a Cabinet Minister, while the 1875 Public Health Act divided the country into sanitary districts required to appoint a Medical Officer of Health and Inspector of Nuisances. All authorities moreover were compelled to provide drainage, sewerage, and an adequate water-supply. Those who wished could also provide parks, hospitals, and public lavatories. The Artisans Dwellings Act of the

same year encouraged local authorities to initiate large-scale schemes of slum demolition and rebuilding. Such legislation was largely permissive. Action in some areas was more vigorous than in others. Town-planning and garden cities were only beginning in the 1880s, but gradually urban conditions and health improved.

Technical developments in industry enabled the tremendous feats in water-supply and sanitary engineering of the Victorian Age. When rivers became polluted iron pipes enabled large supplies of drinking-water to be brought to major towns from great distances. Liverpool and Birmingham laid pipelines into Wales, and Manchester to the Lake District. Water-supplies were also filtered and an annual average death-rate of 23 per 1,000 for 1838–75 had fallen by 1896–1900 to 17·7 per 1,000. This was due to a combination of medical progress, immunization, and public health measures which by the dawn of the twentieth century had made cholera, typhoid, and smallpox in Britain virtually things of the past. In 1907 the Board of Education Medical Department encouraged local authorities to provide medical inspection for elementary school children. By 1918 they were obliged to treat defects discovered and in 1919 the changing role of the central government in health matters reached its logical conclusion in the establishment of a Ministry of Health.

In the U.S.A. repeated outbreaks of smallpox and yellow fever in the eighteenth and nineteenth centuries produced some health measures during these epidemics. Municipal Health Boards were created for example at Baltimore in 1798, Charleston in 1815, and Philadelphia in 1818. New York had one by the cholera outbreak of 1832 but all remained quiescent unless an epidemic was in progress. Most Americans were unwilling to be taxed or inconvenienced at the behest of a sanitary board. A report of the Sanitary Commission of Massachusetts in 1850 drew attention, however, to the urgent need for a new attitude towards public health. This was reinforced by the experiences of the American Civil War in which nearly 2 million soldiers and others succumbed to dysentery, and typhus was a calamitous factor, particularly for the South. After the war, medical officers, inspired by the achievements of Lincoln's Sanitary Commission and those of British sanitarians, returned to lead local health reform movements. In 1864 a group of New York doctors, appalled by the loss of life among the 500,000 inhabitants packed into its

15,357 tenements, determined to conduct a sanitary survey of their city which was 'the grand focus and receptacle of the poverty and filth of Europe'. Their report, with cholera again imminent, produced in February 1865 a Metropolitan Board of Health with sweeping powers to clean the streets. Despite legal and political obstruction between March and November 1866 this removed 160,000 tons of manure from vacant lots, cleaned 4,000 yards and disinfected 6,418 privies. It also made 31,077 nuisance orders, issued vials of anti-cholera mixture to the poor, and organized details for disinfecting the homes of cholera victims immediately a case was reported. Although New York had increased greatly in size between 1849 and 1866 there were only one-tenth as many cholera deaths. Once New York had shown that cholera could be prevented, other cities hastily followed its example and the entire nation ultimately benefited. State health boards followed. Massachusetts was first in 1869. By 1919 all States had organized health departments and a U.S. Federal Health Service had begun in 1870.

While in Britain and the U.S.A. the early emphasis was on environmental hygiene, in Europe public health activity was at first centred upon personal public health. Denmark established free treatment of venereal disease as early as 1790. Germany made vaccination against smallpox compulsory soon after 1796. France provided a system of child welfare clinics, widely imitated in Europe, in 1892, while the Netherlands and Scandinavia were the first countries to train midwives. Most European nations began to build state hospitals in the 1840s and the first extensive systems of state medical insurance also evolved in western Europe. Bismarck's Germany led the way in 1884 and was followed by Austria (1888), Hungary (1891), Luxemburg (1907), and Norway in 1909. Not until 1911, after many recruits had been found medically unfit for service in the Boer War, did Lloyd George's National Health Insurance Act give medical, sickness, maternity, disablement, and sanitorium benefits to 16 million British workers, thus beginning the process of socialization upon which the British National Health Service Act of 1948 was to build.

In contrast, the movement for sanitary hygiene developed somewhat later on the continental mainland. Nevertheless by the early twentieth century the western European pattern had spread to colonial territories, and by association with Germany, to Japan. After the First

54 Improved post-natal care helped cut the infant mortality rate. Here, babies are placed in early incubators heated with stone hot-water bottles, at the Port-Royal Maternity Hospital, Paris, 1884

World War, Turkey and Yugoslavia sought to achieve in a few years what the U.S.A. and western Europe had taken almost two centuries to accomplish. They were joined highly successfully in this bid by the new Soviet Republic, which despite the creation of regional Zemstvos with salaried doctors and hospital building programmes as early as 1861, was still completely lacking in sanitary science. Only in the underdeveloped lands of Asia, Latin America, and the Middle East did sanitary progress lag behind. In consequence 34,000 Chinese died of cholera in 1932 and 10,000 Egyptians in an epidemic of 1947, while in its Indian homeland the 'black illness' still claimed 824,000 victims between 1945 and 1949.

8 A trained medical profession

IMPROVEMENT IN PUBLIC HEALTH and increasing treatment of patients in hospitals created a demand for more and better-trained nurses. In the Middle Ages and in Catholic countries after the Reformation care of the sick was the responsibility of religious Orders such as the Beguines, the Ursuline Nursing Order, and the Sisters of Charity of St Vincent de Paul. Their influence and activity was not restricted to Europe. As early as 1639 Ursuline nuns established a hospital for French colonists at Quebec. Their pupil, Jeanne Mance, went on despite the perils of Iroquois Indians to found the Hôtel-Dieu at Montreal which became one of Canada's finest hospitals. From this time, however, nursing standards sank to a low ebb. In England the sixteenth-century Dissolution of the Monasteries had brought monastic nursing to a close. On the Continent ecclesiastical interference halted professional advance and inaugurated a period often described as the 'Dark Age of Nursing'.

By 1800 nursing in British hospitals was accomplished by those 'who were too old, too weak, too drunken, too dirty . . . or too bad to do anything else'. Almost all nurses were drawn from the ranks of charwomen or domestic servants. Wages were lower than those of women in the Manchester cotton factories. Nurses ate and slept in the wards. While the latter produced immorality, the drunkenness for which they were notorious was encouraged by 'the allowance of one pint or a pint and a half of porter daily . . . with one or two glasses of gin for night duty or disagreeable work'. In workhouse infirmaries, where nursing was undertaken by 'able-bodied paupers', standards were even worse. The reform of nursing throughout the world owes something to the Protestant Institute of Deaconesses at Kaiserwerth near Düsseldorf founded by Pastor Theodore Fliedner. Established in 1833 Kaiserwerth grew until it included a lunatic asylum, an orphanage, two schools, and a hospital. In the last, Deaconesses were trained in the care of the sick. The experiment attracted world-wide

interest and Deaconesses were sent from the mother home to organize similar work throughout Germany and abroad. When Fliedner died in 1864 thirty-two Deaconess houses and 1,600 Deaconesses were spread throughout Germany, Asia Minor, and the U.S.A. A notable visitor to Kaiserwerth was the English Quaker philanthropist, Elizabeth Fry, who upon her return founded the Institute of Nursing Sisters, since she had learned 'the necessity . . . for a class of women to attend the sick altogether different from the hireling nurses . . . generally to be obtained'. Her work paved the way for her great successor, Florence Nightingale, the founder of modern nursing.

Florence Nightingale was the daughter of wealthy and cultured middle-class parents, who rebelled against the trivial round of middle-class society. Her interest in medical matters horrified her mother, who frustrated her attempts to gain nursing experience at Salisbury Hospital in 1844. Nevertheless, although nursing was considered unsuitable for a woman of respectability, she spent three months at Kaiserwerth in 1853. Here she found the hygiene 'horrible' but the devotion admirable and returned even more determined to undertake nursing work. The same year she visited the Sisters of Charity in Paris. Upon her return she became Superintendent of the Institute for Distressed Gentlewomen in Harley Street.

Family disapproval was still strong but she secured an allowance from her father and an independent home. When cholera broke out in London's East End in 1854 she volunteered for work in the Middlesex Hospital. The British government, however, was more concerned with a cholera outbreak thousands of miles away. In March 1854, Britain, France, and Turkey had declared war on Russia and 30,000 British troops had gone to the Crimea. They were dogged by appalling weather and gross mismanagement. Stores, tents, hospital supplies, and clothing never arrived. The soldiers lacked overcoats, blankets, and even boots, while insanitary conditions in the field hastened the spread of cholera picked up *en route* in Bulgaria. By autumn it was more destructive than the enemy. A *Times* correspondent, William Howard Russell, had accompanied the expedition and his despatches painted a horrific picture of conditions at the front and at the huge base hospital at Scutari across the Bosporus from Constantinople. Into this dirty barracks lacking all medical equipment came boatloads of sick and wounded from the Crimea. The first thousand

55 The Scutari hospital after its reorganization. Florence Nightingale (centre left) discusses future plans

cholera cases swamped the hospital; the next thousand the barracks itself. As men died in hundreds of neglect, cholera, and hospital fever rather than their wounds, Russell's outspoken communiqués produced such an outcry that on 15 October Sidney Herbert, Secretary-at-War, and a long-standing friend of Miss Nightingale, invited her as an expert on hospitals to take a party of nurses to Scutari under government appointment. She had already begun to plan such a scheme independently and her letter to Herbert had crossed his to her. Her appointment was a sensation and the decisive step in a career which was to make nursing a profession.

The concept of female nurses to nurse troops was revolutionary. Her team of thirty-eight middle-aged nurses was selected from several religious orders and included eight who had nursed cholera cases in the Plymouth slums. There were no 'ladies', who would be unsuitable for hard work. Pay was from 12*s* to 20*s* a week. The conditions they found were appalling. When the wounded who had survived the crossing disembarked they had to crawl up a muddy slope dragging their comrades who were too ill to move. In the hospital itself four miles of dark, airless corridors were packed with the dead and the

dying in hopeless confusion. The walls oozed with damp; the rotten floors were filthy and the air was polluted by the stench from the sewers beneath the building. In the barracks' cellars 200 prostitutes drank, starved, gave birth to children, and died of cholera. The handful of doctors and orderlies lacked bandages, sheets, bowls, and drugs, and even eating utensils and tables. Nevertheless Miss Nightingale and her team were coldly received since female nurses were regarded as useless in military hospitals.

The nurses could only act under doctors' orders. None were given and they were left angrily to roll bandages and cook 'extras' for the patients from the stores they had brought. The influx of casualties from the battles of Balaclava and Inkerman together with an increasing number of cases of exposure and dysentery produced by the Russian winter created, however, a crisis with which the hospital could not cope, and the nurses finally began the work for which they had come. Miss Nightingale had also a fund from the British government and authority to spend it. She knew what was required and the markets of Constantinople were at hand. 'I am', she wrote, 'a . . . General Dealer in socks, shirts, knives, forks, and tin baths, tables and forms, cabbages and carrots, operating tables, towels and soap.' As the desperately needed stores appeared she gradually took charge. She won the confidence of the doctors to some degree although she had constantly to fight prejudice among hostile officials. She had, however, an iron will, the support of the home authorities, and influential friends in high places. Two hundred scrubbing brushes appeared with yards of sacking to wash the walls and floors; piles of filth were wheeled away in barrows; a laundry was established whereas before her arrival the army had washed exactly seven shirts. Finally the appearance of Alexis Soyer, famous chef of the Reform Club, transformed the kitchens. When more wounded arrived she hired workmen to clean and repair a wing of the hospital damaged by fire. When death-rates stayed high she secured through Lord Shaftesbury a Sanitary Commission to investigate. Two of its three members had been inspectors of the Board of Health. They were accompanied by the Borough Engineer and three sanitary inspectors from Liverpool, the city where sanitary legislation had been longest enforced in Britain. Its arrival in March 1855 was followed by a concerted attack upon nuisances, the cleaning of the sewers, and provision of a better

water-supply. By mid May mortality had fallen to a mere 5 per cent.

With the Scutari hospital satisfactorily organized Florence Nightingale turned to the mainland hospitals, travelling in a cart upon tours of inspection over mountainous tracks in the depths of winter. She caught 'Crimea fever' and almost died but still refused to return home until the war was over and her hospitals empty. When she finally returned to be received by the Queen the thin, white-faced figure was barely recognizable. It is possible to exaggerate her part in the improvement of hospital conditions but the stories of returning soldiers, who idolized her, and Russell's despatches had turned her into a living legend.

'When all the medical officers have retired for the night', wrote Russell, 'and silence and darkness have settled . . . upon those miles of prostrate sick, she may be observed alone with a little lamp in her hand making her solitary rounds.' This legend she now used to good purpose for her reform of nursing had only just begun. With her nurses safeguarded by her official recognition as General Superintendent of the Female Nursing Establishment of the Army she devoted much of the rest of her long life to the preparation of reports on the reform of military and civil hospitals. Her *Notes on Hospitals*, recommending better sanitation, construction, and management, published in 1859, were widely read as were her *Notes on Nursing* published in the same year. Her advice, given by now from an invalid couch, influenced barracks and hospital construction in India, Holland, France, and Portugal as well as throughout Britain. Soon after the outbreak of the American Civil War her suggestions were requested for the organization of hospitals in the Northern States. Her prime aim, however, was to secure the effective training of nurses. In recognition of her services in the Crimea, a grateful public had opened a Nightingale Fund to enable her to 'establish and control an institute for the training, sustenance, and protection of nurses'. Significantly few of the subscribers were medical men but the British soldier had learned the value of female nurses and almost £9,000 of a total of £50,000 was subscribed by the army.

The fund was used for opening the Nightingale School of Nursing at St Thomas's Hospital in 1860, which marked the establishment of nursing as a profession. The School did not provide the first nursing training in Great Britain but Miss Nightingale's Crimean

56 Mrs Deebles of the Army Nursing Service and her assistants, dispatched to Natal in 1879. By this date the service was strongly established

adventures had drawn public attention to the problems of nursing and taken the first step towards making it respectable, thus enabling her to transform recruitment and training. The nurse, she believed, should be a skilled auxiliary to the doctor, who could treat and supervise patients according to his directions. To accomplish this the nurse required a suitable disposition, some medical knowledge, and much supervised practice. At the Nightingale School this training was provided largely by Mrs Wardroper, Matron of St Thomas's Hospital until 1887, who actually trained the nurses selected by Miss Nightingale. Control of nursing staffs thus passed into the hands of women. By the 1880s and 1890s nursing had established itself as a suitable and respected career for women who chose to abandon the sheltered life of Victorian womanhood. Miss Nightingale's nurses, moreover, became missionaries in the nursing reform movement which had to fight male doctors, lay administrators, and members of hospital committees, and whose matrons sought and gained great power in institutions previously controlled by men.

From 1860 to 1903 the Nightingale School certified 1,907 nurses

as having had one year's training. The new order spread as each trained nurse trained others. Miss Nightingale, acting as a clearing-house for nursing appointments, steered candidates of whom she approved into key positions at home and overseas. The School became in fact, a training-school for matrons rather than nurses and steadily hospitals in Britain and abroad acquired in turn matrons, nursing schools, and nurses of the new type. In Australia, Lucy Osburn, a Nightingale nurse, founded the first nursing school at Sydney Infirmary in 1868, which set the pattern for future nursing education there. Similarly in the U.S.A. in 1884 Alice Fisher established a training-school for nurses at Blockley Hospital, Philadelphia. Before her arrival 3,000 sick and insane patients were nursed by convalescents or the lowest class of attendant. In four years she revolutionized nursing standards and created a nursing school which other hospitals imitated. By 1887 Nightingale nurses had penetrated Australia, Canada, America, India, Sweden, Germany, and Ceylon.

The efforts of the 'Lady with the Lamp' did not end there. In 1861 she also interested herself in the new idea of District Nursing begun by William Rathbone, a wealthy Liverpudlian who at his own expense had introduced the first District Nurse in his city. In conjunction with Miss Nightingale he persuaded the Liverpool Royal Infirmary to establish a training-school along Nightingale lines, whose nurses would work in the homes of the sick poor. Inevitably a Nightingale nurse, Miss Merryweather, was its first matron. By 1887 most large British cities had by voluntary effort organized District Nursing services which were afterwards extended to rural areas. Their example was subsequently followed by the 'Bush' nursing service in Australia, 'Back Block' nursing in New Zealand, the Canadian Royal Victoria Order of Nursing, and 'Visiting Nursing' services in the U.S.A.

To William Rathbone also goes credit for the initial reform of Poor Law nursing. In May 1864 he persuaded Agnes Jones, a Nightingale nurse, to bring twelve nurses to Liverpool's Brownlow Hill Workhouse to organize a nursing school and care for 1,200 sick paupers. Conditions resembled those of the Crimea. After dark policemen patrolled the wards to keep order. The Nightingale nurses, however, revolutionized the nursing and ward administration. When Agnes Jones died in 1868 from typhus caught from a patient she had shown that trained nursing could transform a workhouse infirmary.

Pauper nurses were still used in many workhouses but after 1897 trained nurses were employed on an increasing scale.

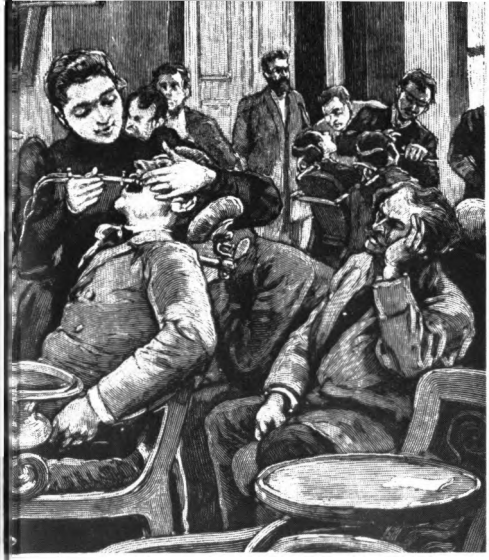
Perhaps the only mistake which Miss Nightingale made was her failure to recognize the advantages of state registration. Government recognition, she feared, would destroy the qualities of character and perception which she required in her nurses. New Zealand introduced an Act concerning registration in 1901. Cuba, Canada, Australia, Austria, Belgium, and Germany followed. In Britain an Act of 1902 made it illegal for any but doctors, registered midwives, medical students, or pupil midwives to attend women in childbirth, but state registration of nurses, first mooted in 1886, was still unachieved when Florence Nightingale died in 1910. After the First World War, however, most European countries recognized the legal status of their nurses and introduced state training schemes. Britain was no exception and the wartime services of thousands of British nurses earned them the right to organize their profession by the Nurses Registration Act of 1919.

The second half of the century saw also an improvement in the status of other medical practitioners. In Britain at the beginning of the century there was still a deep division between physicians, apothecaries, and surgeons. Physicians, with medical degrees, were the recognized leaders of the medical profession and usually practised among the well-to-do or served as consultants. The General Practitioner was normally an apothecary. Originating as chemists, apothecaries had begun to attend patients and prescribe drugs themselves from the second half of the seventeenth century. The Society of Apothecaries founded in 1617 could also, after 1815, examine and licence candidates as general practitioners. Their status, however, was low in the public eye and their income, even if they had a post as a parish doctor, was small. Frequently they paid for medicines prescribed out of their own pockets and when they worked day and night during the cholera epidemics these 'tradesmen' received no additional reward. As early as 1800 the Royal College of Surgeons was established issuing a diploma with the right to practise surgery. Not until 1858, however, did a Medical Registration Act set up a General Medical Council to regularize qualifications and protect the public from charlatans. Its principal duties were to compile a medical register of those qualified to practise, to improve medical education,

to publish an official pharmacopoeia, and to discipline those who broke the doctor's ethical code.

One of its first problems was to determine whether it should accept women. Elizabeth Blackwell, a Bristol emigrant, had already become the world's first medical graduate in New York in 1849. The following year the first women's medical college had opened in Philadelphia. In Britain it was not until 1865 that Elizabeth Garrett Anderson, after study at three medical schools, broke the sex barrier and forced the Society of Apothecaries to allow her to take their examination. It was another twelve years before any other woman joined her as a result of her efforts to help women to become doctors. Edinburgh was the first British University to admit female students in 1869. They were instructed in separate classes and not given equal status with men until the beginning of the twentieth century. By the time one of Edinburgh's most notable women students, Sophia Jex-Blake, had qualified in 1876, however, the General Medical Council had agreed to register women.

Another early achievement of the Council was the professional establishment of dentistry. In the eighteenth century dental 'transplants' from the poor or the dead were rammed into a prepared socket in the recipient's jaw or set in ivory gums. In the nineteenth century 'Waterloo teeth' and teeth from American Civil War dead were still shipped to England by the barrel-load. About 1845, however, an improved type of single, porcelain tooth, which could be set individu-



57 Elizabeth Garrett Anderson, the first British woman to qualify as a doctor in 1865, is made an M.D. and breaks another barrier at the Faculty of Medicine in Paris, 1870

58 By the 1890s dentistry had become more scientific. Some women were anxious to get training, as this scene in the Paris Dental Clinic in 1892, shows

ally in plates, was devised by the American, Claudius Ash. To Ash teeth were added another American invention, vulcanite facsimiles of the gums. Following the Dentists' Act of 1878 British dentists were registered, disciplined, and had their training supervised in the same way as doctors.

In America the status of doctors had reached an all-time low in the nineteenth century. Even the most credulous doubted their claim to the dignity of a learned profession. This was partly because of their failure to combat cholera and partly because of the inadequacies of medical education. Requirements for admission to medical school were rudimentary. Courses were often no longer than six months. By 1851, fifteen States had repealed all regulations concerning the practice of medicine. Eight others had never had any. Medical education, however, was greatly influenced by the example of the Johns Hopkins Medical School which from 1893 admitted only college graduates with a year's training, and slowly the professional image of American doctors improved. The work of the medical scientists and the reforms in nursing and public health also brought an immense stimulus to the practice of medicine and surgery in Europe and America. Fields became so wide and new skills so demanding that automatically the growth of specialists followed to aid in a battle in which for the first time many species of disease were in retreat.

9 The twentieth century: the eternal struggle

AN INDICATION OF THE INCREASING POTENCY of medicine was provided by the wars fought after 1870. For the first time, in the Franco-Prussian War (1870–71), more died in battle than of disease, a trend which continued in the Russo-Japanese conflict of 1904–5 and the First World War. In the last, however, new problems were posed for surgeons by the many wounds resulting from new high-explosive shells. Enormous casualties, the frequent infection of wounds by dirt, and the difficulty of evacuation from the front line meant that many for whom there was no hope were left to die. In the conditions of trench warfare wounds became grossly infected. After 1915 deep, gaping wounds were treated with a solution of hypochlorite named 'Dakin's solution' after one of its inventors. In the forests and swamps of the Eastern Front tetanus was rare, but on the well-manured terrain of Flanders wounds were easily infected and cases were numerous. Most who contracted it died until a vaccine was developed which provided almost complete immunity. Another barrier was overcome when blood transfusion was first effectively used. Transfusion had been made a practical reality when Karl Landsteiner had discovered in 1900 that all individuals belonged to one of four major blood groups, some of which reacted adversely if mixed with others. Sir Harold Gillies also worked to restore the disfigured bodies of soldiers by means of plastic surgery, while typhoid, one of the most formidable foes in the Boer War, was relatively rare even in unhealthy Gallipoli thanks to the success of anti-typhoid inoculation. On the other hand, typhus again erupted violently. In the East troops retreating from the Balkans and Russia brought with them lice and disease. In Serbia 150,000 people died in six months. Charles Nicolle, Director of the Pasteur Institute in Tunis, had discovered in 1909 that typhus was carried by body lice. Although the microbe itself remained unidentified until 1916 elaborate delousing measures were enforced by army authorities. None the less,

about a million soldiers on both sides were infected. In the disastrous post-Revolutionary upheaval in Russia from 1918 to 1922 it looked for a while as if the fate of the Revolution was at the mercy of typhus. 'Either socialism will defeat the louse', stated Lenin, 'or the louse will defeat socialism.' In the end socialism in the form of quarantine stations, fumigation, and compulsory 'bath weeks' won the day but of 30 million cases about 3 million died.

The end of the war was the signal for a fresh outburst of medical discovery. In 1921 a young Canadian surgeon, Frederick Banting, and his assistant, Charles Best, discovered and isolated insulin, the body hormone that helps to regulate the storage of sugars and injections of which have since enabled diabetics to live near-normal lives. In 1928 Vitamin C was isolated in pure form and it was gradually realized that the lack of numerous other 'accessory food factors' could cause diseases such as beri-beri and rickets, curable by taking the appropriate vitamin in tablet form. The same year saw also the production of a long-awaited yellow fever vaccine.

Ever since the discovery of salvarsan scientists had been searching for other 'magic bullets'. Many chemicals were found which would kill germs in the test-tube but not in the body. It began to seem that Ehrlich's discovery was fortuitous and no others existed. A German bacteriologist, Gerhard Domagk, who had already experimented with hundreds of new dyes, began in 1932 to work with prontosil, a new red dye manufactured by I. G. Farben. In experiments on thousands of mice he found it killed or weakened many germs of the 'coccus' group which caused a variety of septic infections. His first human patient was his own daughter, who in 1935 had contracted blood-poisoning and was on the verge of death. A large dose of prontosil cured her and Domagk published his findings upon the first of the sulphonamide drugs, so called because their working part was a chemical made from coal-tar, one of the sulphonamide chemicals. It was quickly realized that other sulphonamides might have similar effects. The firm that found one would make a fortune. Hundreds of sulphonamides were isolated and tested. One of the many firms involved was the British company of May & Baker, which was searching particularly for a sulphonamide which would kill pneumonia germs. In 1938, one of their researchers, Lionel Whitby, found that the 693rd substance they prepared worked. Soon M & B brought recovery to

59 An American field dressing-station in France, 1918

60 Sir Frederick Banting, 1923, discoverer of insulin

nine out of every 10 patients. With these developments the pharmaceutical industry began a phenomenal growth. Sulphonamides were not to last long as the only 'miracle cures'. By 1939, when Domagk received the Nobel Prize for his work, production of a new type of anti-bacterial drug, penicillin, was imminent.

Penicillin had been discovered before prontosil. Alexander Fleming, its discoverer, had spent four years in the Army Medical Service in the First World War, where he had seen the ineffectiveness of antiseptics in dealing with wounds. What was required was a 'magic bullet' like salvarsan which was effective against many more types of bacteria. In 1928 Fleming noticed that a mould, which invaded one of his culture-plates on which he grew bacteria, had prevented the growth of bacteria round it. Fleming cultivated the mould first on jelly and then in broth. He found that it was a powerful 'natural' antiseptic but did not fully realize its potential value and failed to isolate the actual germ-killing substance in the mould liquid. Work on penicillin was neglected until 1939, when two Oxford doctors, Howard Florey, and a German Jewish refugee, Ernst Chain, began

61 Charles Best, Nobel prize-winner, 1923

62 Sir Alexander Fleming, who discovered penicillin by chance in 1928

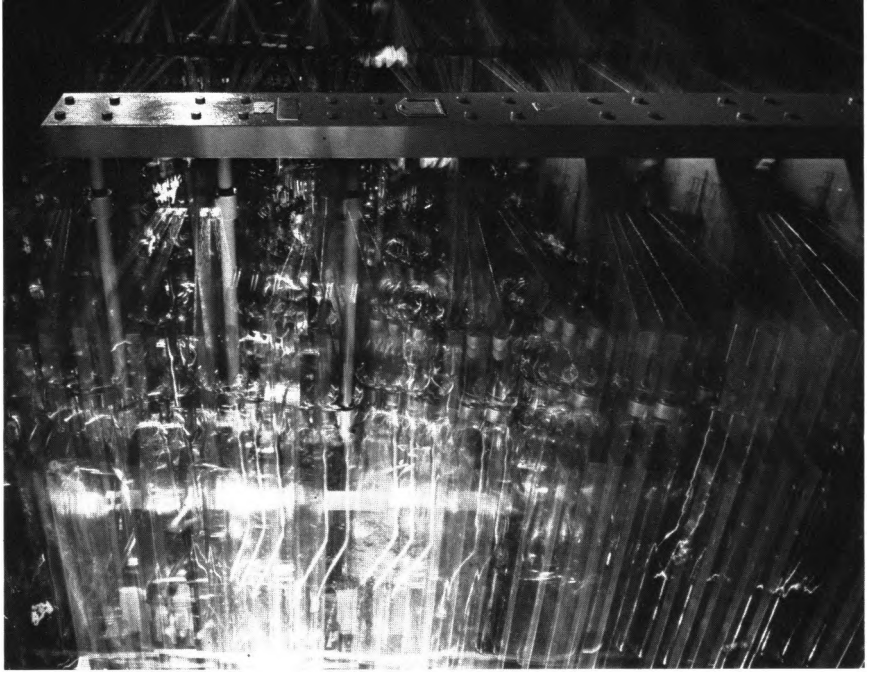
to reinvestigate its properties with a team of assistants.

After months of work Florey isolated the pure chemical substance and found that it was indeed a germ-killing agent effective in human beings. It required, however, twenty gallons of penicillin broth and hundreds of hours of work to produce sufficient to treat one person. By 1941 Britain was at war. Her primary industrial concern was with armaments. Florey and Chain therefore took their data to the U.S.A. hoping to persuade the Americans to undertake production on a scale impossible in wartime England. America's entry into the war in December 1941 finally convinced her government of penicillin's importance. Vast sums were provided by government funds and private drug companies and mass production began. A technique was discovered whereby it could be fermented in huge vats instead of the humble milk bottles and churns used in Oxford. In 1942 only sufficient was produced to treat fifteen soldiers in the whole British 8th Army. By 1944 it was available in every battle theatre and civilian hospital, where it saved countless lives. While the sulphonamide drugs prevented the growth or multiplication of bacteria, penicillin killed

approximately sixty different bacteria outright. In 1945 it was still expensive but further research, together with the British achievement of making it artificially, made it cheaper to produce and more efficient in the treatment of wounds, pneumonia, syphilis, and other complaints. By 1943 another team of researchers led by Dr Selman Waksman of New Brunswick had discovered in soil samples a further antibiotic called streptomycin, which, unlike penicillin, destroyed the tuberculosis germ and was effective against over seventy germs that penicillin could not kill. In the late 1940s yet more antibiotics, the tetracyclines, were discovered with an even wider range of action.

The reduced casualties of the Second World War were a clear tribute to the advance of medical science. There were fewer casualties, not only because battles were more mobile and evacuation to hospitals behind the lines was possible by air, but with sulphonamides and penicillin, infection of wounds had ceased to be a surgeon's nightmare. Blood transfusion was easier and the technique of the blood drip, which could be administered even in moving ambulances, was perfected. Blood banks were established, saving thousands of air-raid and battle casualties. The value of anti-tetanus inoculation was demonstrated during the British retreat to Dunkirk when among 16,000 men wounded in farming country only 7 cases occurred. The Swiss chemist, Paul Muller's discovery of the pesticide D.D.T. in 1939 also brought typhus under almost complete control. When there was a serious outbreak in war-torn Naples in 1943–44, 1½ million people were dusted with D.D.T. powder and in three weeks it was halted. New developments in plastic surgery in which Sir Alexander MacIndoe led the way, produced skin grafts and other operations to aid airmen burned in air crashes and civilians disfigured by incendiary bombs. After the war developments continued. Psychotropic drugs, affecting the mind, were discovered or developed in the mid-1950s to supplement electro-convulsive treatment pioneered in 1934, and today innumerable tranquillisers, sedatives, stimulants, and mood elevators are widely used for psychiatric problems.

The 1950s also saw the conquest of the twentieth-century disease of poliomyelitis. The poliomyelitis virus attacked and paralysed adults and children in the more highly developed countries where better health and sanitation prevented the immunity granted by childhood infection in more primitive lands. By the 1920s it was an



63 Production of the Salk vaccine. Bottles containing the suspended kidney cells are being gently rocked at a constant temperature of 36 °C

annual threat in Europe and North America. It tended to single out the most active and athletic and in 1921 crippled the future American President, F. D. Roosevelt. In 1949, when there were 43,000 cases in the U.S.A. alone, three doctors in the Harvard Medical School at last isolated the polio virus. A host of researchers financed by a national fund found that three types of virus grew in the human intestine and were carried in water and food to other contacts. In April 1954 Dr Jonas Salk began massive trials of a polio vaccine. By the end of the summer 1,830,000 children in America had been successfully protected and in the following year the Salk vaccine began to be produced upon a national and then a world basis. Another vaccine, this time against measles, which had long eluded medical research, was introduced ten years later.

In the operating-theatre and hospital the post-war era completed the change over to the 'machine age of medicine' with its dependence upon laboratory tests and special instruments of treatment and diagnosis. Aseptic surgery required properly lit, cleaned, and heated

theatres with a room for sterilization by gamma radiation or ethylene oxide gas, and an anaesthetic-room where the anaesthetic would be started. Mechanics too were needed to service the new electrical and mechanical surgical aids such as torches for the internal inspection of the stomach, lungs, bowel, and bladder; elaborate anaesthetic machines; the diathery, a precisely controlled, electrically heated successor to the medieval cautery; and heart-lung machines which perform the work of the heart or lungs when circulation and breathing are stopped for an operation. Elsewhere in a hospital will be found oxygen tents, electronic monitors for patients whose pulse, respiration, and blood pressure are simultaneously recorded, iron lungs, which save the lives of polio victims, kidney machines, radiotherapy and X-ray units, machines which read the chemistry of the blood and other body fluids, together with a variety of aids to nursing, physiotherapy, occupational therapy, and diatetics developed during the last half century.

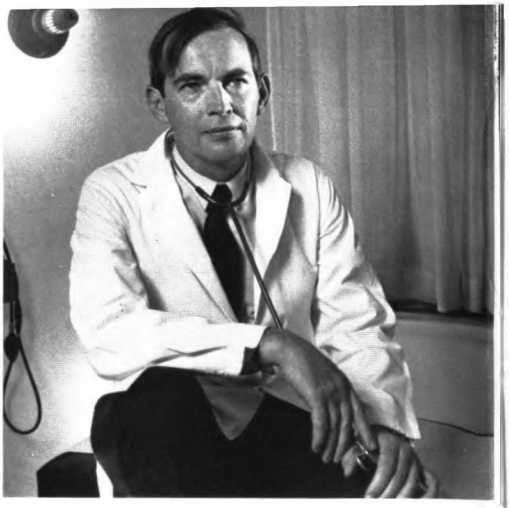
Post-war surgeons were also looking for ways of transferring tissues and even organs from one person to another and from the dead to the living. Initially 'spare-part surgery' was centred upon the kidneys. The technique of kidney transplantation had been worked out upon dogs by Alexis Carrol, a French surgeon, at the beginning of the century. In 1961 a kidney was transferred from one man to another. Later, kidneys were obtained after death from healthy persons who had died in accidents. By 1966 over 600 kidneys had been transplanted in various parts of the world. Although technically perfect, the results were disappointing since the body showed a tendency to rejection one or two years later. Nevertheless by 1967 surgeons were also preparing to attempt human heart transplants. Heart surgery was sufficiently advanced by 1945 for surgeons at Baltimore General Hospital to conduct the first 'hole in the heart' operation by which the inherited heart defect causing 'blue babies' could be cured. By 1960 this operation was almost commonplace and surgeons had successfully fitted to the heart plastic valves, portions of plastic artery, and even installed electric 'pacemakers', to trigger the pumping action of hearts weakened by disease. In the absence of any equivalent of the kidney machine a heart transplant had to be done quickly. The first successful transplant was accomplished on 2 January 1968 in South Africa by Professor Christian Barnard.

Barnard's first attempted transplant had failed. His second attempt gave Philip Blaiberg, a sixty-year old dentist, the heart of a coloured factory-worker and an extra nineteen months of life. Similar transplants followed in South Africa, Britain, and the U.S.A. but although the technical problems had obviously been overcome the problem of tissue rejection remained and the death-rate was high. Nevertheless doctors believe that a solution to rejection is round the corner.

Just as in the nineteenth century many states began to assume some responsibility for public health so in the twentieth century the state has grown to accept an increasing responsibility for personal health. In Russia, where no organized medical profession existed until well into the nineteenth century, free medical treatment was introduced by the Soviet Labour Code of 1922 and was imitated in those lands which became Communist after the Second World War. Britain also established a free National Health Service in 1948, whose cost was spread across the community through insurance contributions and general taxation. Later this was modified to include small charges for medicines, spectacles, false teeth, and dental treatment, but the patient can still visit his doctor and obtain hospital care, surgery, or specialist treatment without further cost. Other Western countries and the U.S.A. still prefer to rely upon private insurance schemes, often to some extent controlled by the government, although in 1965 President Johnson introduced in the U.S.A. a free national scheme of Medicare for old people.

Disease knows no frontiers, as the great epidemics had clearly shown. With dramatic improvements in land, sea, and air travel international effort clearly became essential for its control. Attempts to reach agreements on health matters were made in 1851 when twelve European states met in Paris to discuss quarantine and the origins of infection. Similar meetings continued until the close of the century but no real progress ensued. Meanwhile, another step towards international medical co-operation was more fruitful. In 1862 Henri Dunant, a Swiss who had seen the suffering at the Battle of Solferino in 1859 published his *Memory of Solferino* suggesting a volunteer service in all civilized countries to succour the wounded without distinction. As a result, sixteen states signed the Geneva Convention in 1864, recognizing doctors and nurses as non-combatants free to tend wounded of all nationalities, and respecting military hospitals

64 A heart and lung machine in use at Hammersmith Hospital in 1956



65 Dr Christian Barnard, who performed the first successful human heart transplant operation in 1968

as safety zones. In honour of Dunant and Switzerland the colours of the Swiss flag were reversed to provide a distinctive emblem for Red Cross Societies throughout the world. A Red Cross Society was founded in America by Clara Barton. In 1905 a British Red Cross Society embraced the entire Commonwealth and during both wars this linked with the Order of St John of Jerusalem to become the largest organization for the wounded that the world had seen. In Switzerland, Germany, France, and Japan the Red Cross controls nursing schools, and in Canada, the U.S.A., Finland, and elsewhere also plays a large role in training nurses for public health work. Today there are some ninety national societies with a membership of 169 million whose work throughout the world is invaluable at times of flood, fire, earthquake, and disaster and is organized through the International Red Cross.

Despite the success of the Red Cross, international co-operation on public health matters still remained to be achieved. A Pan-American Sanitary Bureau was created at Washington in 1902 and in 1909 the first international organization, the Paris Office, was established. This was superseded by the Geneva Office, a health organization set up in 1923 by the League of Nations, which reported on public health topics. Not until April 1948 was a World Health

66 An Iranian boy protects his eyes as he is dusted with D.D.T. powder

67 Red Cross members give aid in Managua

Organization established by the United Nations Organization which, with the United Nations Children's Fund, has contributed enormously to world health. The W.H.O., with headquarters at Geneva, and regional centres for most areas of the world, had in 1962 115 member countries and exists to promote all forms of health measures particularly on an international scale. Its quarantine regulations are designed to prevent the spread of epidemics such as cholera, plague, typhus, and yellow fever for which it watches carefully. It also maintains international standards for drugs and helps to develop the medical and public health services of underdeveloped countries, assists with emergency aid, and fights the world's major diseases, which despite the medical discoveries are still virulent in some areas. To date its major successes have been the eradication of yellow fever and malaria from large parts of South America and Asia while an anti-smallpox campaign, commenced in 1967, plans to wipe out smallpox by the mid-seventies.

Much, however, remains to be done in the underdeveloped countries where half the world's people are unable to obtain sufficient food or to live decently. Trachoma, against which there is no vaccine, still accounts for at least 400 million victims and is responsible for 80 per cent of preventable blindness. India alone provides nearly

4·5 million of the world's 15 million blind, despite a National Trachoma Control Programme launched by its government with the aid of the W.H.O. in 1963. Tuberculosis still brings 3 million deaths a year and 100 million people in warm countries are still affected by bilharziasis. Part of the solution lies in improved medical services. The U.S.S.R., one of the most medically backward European nations in 1919, has 1 doctor for every 433 people and 1 hospital bed for every 107. Britain has 1 doctor for every 860 people and 1 bed for every 100. In the U.S.A. there is 1 doctor for every 650 people and 1 bed available for every 320 citizens. In contrast newly independent countries like Mali and Nigeria have 1 doctor for every 50,000 people while in Pakistan and Ethiopia there is only 1 bed for every 2,500. Low living standards, lack of health education, and poor environmental sanitation are still major causes of disease as they were in nineteenth-century Europe. Lack of accessibility is another reason why half the world's population still lives and dies without seeing a doctor and why with inadequate facilities and funds such doctors as are available have often written off this generation and are striving to save the next by spending available money on preventive vaccination.

In the vast distances of Africa and Australia earlier medical missionaries like Albert Schweitzer, who worked for half a century in a primitive hospital in French Equatorial Africa, have been succeeded by Flying Doctor services designed to break down the medical isolation of barren and thinly populated areas. As early as 1917 a Presbyterian minister, John Flynn, influenced by war-time developments in radio and aviation, proposed a system of flying doctors working from inland Australian bases, who would be able to carry medical help across deserts, floods, and mountain ranges. He was ahead of his time but in 1928 the first medical flight was made from Cloncurry in Queensland. The following year Alfred Traeger, an electrical engineer, produced a radio transmitter powered by using bicycle pedals and the Flying Doctor Service of Australia grew to provide thirteen bases covering nine-tenths of the continent. A similar service now exists in the East African Bush covering an area as large as western Europe, but its work is hindered by limited funds.

Although medicine has the ability to counter successfully the majority of the old epidemic diseases, no effective preventive for influenza and the common cold, which cause the annual loss of millions

68 An ambulance plane lands in the far north of Canada to pick up an old woman suffering from appendicitis

of working days in many countries, is available. The world-wide influenza pandemic of 1918–19, which was a cruel epilogue to the First World War and in which approximately 27 million people died, was a timely reminder of the potency of this disease. Originating in an overcrowded army camp in Kansas in March 1918 the virus was carried to Europe by U.S. soldiers in the closing stages of the war. Cases in the U.S.A. reached 20 million, while in Europe American doctors treated 70,000 victims in their hospitals in France with a death-rate of 32 per cent. By June 160,000 citizens of Berlin and half the population of Manchester were down with flu. London had a death-roll of 15,000 and in Philadelphia 650 people died in a single day. The worst ravages, however, were in Africa and Asia. Influenza rolled 'like a tidal wave' over China, and in India alone more people died than in all active combat throughout the war. Various vaccines were tried before a second, less fatal pandemic afflicted the world in 1957–58, but none has yet been discovered which is completely effective against all strains of flu.

In developed countries, which have virtually eliminated the effects of malnutrition and mass infections, new maladies have taken their place. Cardio-vascular diseases arising from the pressures of modern living, lack of exercise, and over-indulgence in fatty foods are now the primary cause of death in Europe and the U.S.A. The pace of modern life has also produced an increase in mental illness. In the

69 The fight against malaria. The officer organizes his spraying equipment in Mexico

70 An Andean Indian child suffering from malnutrition

advanced countries of Europe and North America almost half of all hospital beds are occupied by the mentally ill. Suicide in western Europe is the sixth most common cause of death. Cancer, a disease of hidden origins, arising sometimes from a virus, sometimes from a chemical like the tar in cigarette smoke, and sometimes from a type of radiation, is another scourge on the increase in the Western world where the atmosphere, polluted by fumes from industry and motor traffic, is also creating chronic bronchitis. The spread and volume of motor traffic and an increase in the number and complexity of industrial machines and domestic appliances demands a high price. Road, domestic, and occupational accidents now rank third among the causes of death in European countries. An increase of venereal disease is straining the system of treatment to breaking-point. Drugs, too, although valuable aids if properly administered by a doctor, are open to serious misuse, and an increase in drug-taking with disastrous results is another regrettable feature of modern society. Drugs also

have side effects ranging from minor drowsiness to the recent tragic aftermath of the drug thalidomide which caused the babies of mothers who had taken it during pregnancy to be born deformed. Not only does drug production require the strictest control but bacteria can develop a resistance to antibiotics and even thrive in their presence just as some insects have grown accustomed to pesticides. The struggle for health is therefore not only universal but eternal.

Medicine's greatest problem, however, is self-created. It has kept alive largely because of its victory over epidemic disease millions of people who would otherwise have died, especially in infancy or childhood. Average life expectancy in ancient Greece was about thirty years; in England in 1870 it was forty years, and in 1931 fifty-eight years. Today it is about sixty-nine years. A death-rate in Britain and the U.S.A. of 17·3 per 1,000 in 1900 has fallen to 11·9 and 9·6 per 1,000 respectively. The result has been a population explosion. A world population of 700 million in 1800 had more than doubled by 1919 and today stands at 3,600 million. By the year 2000, with the birth of 5 million babies a month, it is expected to reach the colossal total of 6,000 million. In Western countries, the dramatic decline in the death-rate has not brought serious overpopulation because of an associated decline in the birth-rate which occurs in societies enjoying higher living standards. Here the social and medical problem is fast becoming the care of the increasing number of the aged. Four-fifths of the annual increase in population comes in Asia, Africa, and South America despite the fact that one-fifth of the 100 children born every thirty seconds still die in their first year. Here since 1945 modern medicine, hygiene, and insect control have been applied without any corresponding improvement in general living standards and the birth-rate has continued to increase. These peoples have only one-third of the world's food-supplies. Their disease, hunger, poverty, and ignorance can only be eliminated by the unselfish economic and medical aid of the richer nations. Unless they are eliminated the political, social, and medical problems of the underdeveloped countries could become catastrophic. If they are eliminated, however, some limitation of world population is essential or it will outstrip the productive capacity of the earth. In both tasks medical science has a vital role to play.

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